A SURGICAL HANDBOOK

CAIRD & CATHCART

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'Varsity 1922.

A

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SURGICAL HANDBOOK:

FOR THE USE OF

Students, Practitioners, House-Surgeons, and Dressers.

BY

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PUBLISHERS' NOTE TO EIGHTEENTH EDITION.

The Eighteenth Edition includes the important note on "Antiseptics in time of War" added to the last Edition, and in all other respects the book remains as revised for the Sixteenth Edition.

January, 1919.

PREFACE TO SIXTEENTH EDITION.

In this Edition considerable alterations have been made throughout the Book, but especially in the Chapters dealing with Anæsthesia, with the treatment of Fractures, and with Spinal Caries. Many of the older diagrams have been withdrawn, and a nearly equal number of new ones have been added. In spite of large portions of the older text having been deleted to make room for the new, the Publishers have been obliged to add over forty pages to this edition. The Authors trust that the book will continue to be found useful by those for whom it is intended.

Edinburgh,
May, 1914.

PREFACE TO FIRST AND SECOND EDITIONS.

In complying with the wish of the Publishers to write the following Manual, the Authors have endeavoured to make it as practical, and as thoroughly in keeping with modern surgical methods, as possible. They hope that it may prove a convenient and ready help to those engaged in active surgical work.

The illustrations have been mainly taken from drawings from nature by W. Scott, M.B.; figures 5, 7, 8, 94, 122, 123, 129, 130, 133, are from Porter's "Surgeon's Pocket-Book," and figures 178-184 from Landois and Stirling's "Text-Book of Physiology."

Their best thanks are due to Professor Tait, who has kindly revised the chapter on Electricity, and to J. H. A. Laing, M.B., who has given valuable assistance in preparing the drawings illustrating Massage.

In conclusion, there only remains to say, that, while both Authors share the responsibility of the whole book, each has chosen certain departments. Thus, F. M. Caird has undertaken Chapters III., IV., XI., to XVII. inclusive, and XXVIII., and C. W. Cathcart the remainder.

Edinburgh,
March, 1889.

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A SURGICAL HANDBOOK.

CHAPTER I.

CASE-TAKING.

Contents.—Importance of accurate "Case-taking"—How to record a case—Outline of a systematic plan—Application.

THERE is no part of a Medical Student's training more important than the duty of systematically recording the condition, treatment and progress of patients, when under Medical or Surgical care. The student's powers of observation are sharpened by this practice, and he learns how to apply these powers thoroughly, because systematically, and thus, eventually, with both rapidity and exactness. It cannot be too strongly urged that a true knowledge of disease, which is the great secret of success in diagnosis and treatment, can only be founded on the careful and accurate study of individual cases.

In the Hospital practice of a Medical School, therefore, the objects of case-taking are no less scientific and practical than educational, and the student should begin from the first to form a collection of his notes of personal observations of disease, with the express purpose of continuing the practice throughout the rest of his career. He ought to acquire the art of writing shorthand, which, apart from many other advantages, will enable him to do this work in at least a third of the time and with a sixth of the labour entailed by longhand. (See *Appendix*.)

How to Record a Case.—Descriptions of cases may be either written into a regular case-book, or they may be first taken on separate sheets of paper, and afterwards bound together. In either way, the cases must be systematically indexed for future reference. (See *Appendix*.)

Outline of a Systematic Plan.—When a student begins to take cases, he should have a Tabulated Scheme before him, as a guide to the questions which he is to ask.

This outline being framed to suit all kinds of cases, will be too full for those in which only one organ or part of the body is affected. Still, it is well to form a habit of systematically examining every

important organ or system, and should nothing be wrong, the phrase "health otherwise good," or "other systems normal," will express what is wanted. Upon the due action of every important system depend the health of the individual, his tendency to inflammation, his power of healing, and his resistance to the influence of micro-organisms.

It is usual in hospitals to have the case-taking card on a separate slip of paper, so that it may be used conveniently at the bedside. The following scheme embraces what is generally required :—

Scheme for taking Surgical Cases.

The heading should be filled in after the case is finished. It should form a brief epitome of the case to catch the eye, stating the disease or injury, the patient's name, the operation, or special treatment, the result, with dates of admission, operation, and discharge (see illustrative case, p. 4). This heading is most suitably placed on the outer covering of the finished record, or it may precede the following details with which the account of the case begins :—

Name—Age—Married or Single—Occupation—Postal Address—Previous Medical Attendant (for future reference)—Date of Admission—Surgeon in Charge—No. of Ward—Hospital—Patient's own Statement of Complaint (as distinguished from any previous medical attendant's diagnosis).

History of Present Disease or Injury.—To bring out (1), *if disease,* its time and mode of onset, its supposed cause, and its progress; also, the result of any treatment previously employed. (2) *If an injury,* the time and exact mode of occurrence, consequence up to date, and result of treatment employed.

History of Previous Health.—Noting especially any serious illness or accident, any troublesome complaint, especially any manifestation of syphilis, tuberculosis, or rheumatism, or any previous attack of the present disease. Dates should be given, preferably as so many weeks, months, or years before the date of admission, or at the period at which the illnesses or accidents occurred.

Social History.—Patient's occupation and surroundings. Habits, as to ventilation, exercise, food, alcohol, and tobacco.

Family History.—To find out if there be any taint of syphilis, or any tendency to tubercle, gout, rheumatism, or tumour growth, or to weakness in any special organ or system. If patient has had children, state their number; the number living and their condition of health; if any dead, the age at death and cause of death.

Condition on Examination.—Date of examination, which should be as soon as possible after admission. Begin by a brief, pointed description or word picture of the patient. Note any condition of shock, excitement, coma, intoxication, or other abnormal condition that may have been present on admission, even though it may have passed off; also any special character of the gait, need for support, or mode of lying.

1. *Affected Part.*—(*a*) Subjective—Patient's sensations, as to heat, pain, throbbing, stiffness, or other cause of complaint.

(*b*) Objective—(1) *On inspection*, note any change in colour, size, form, contour, position. A cast should be taken, or a sketch in pencil, pen and ink, or water-colour, or a photograph should be here inserted where the case admits of such illustration. State abnormalities in size by measurement. (2) *On palpation* (handling), note the relative temperature; the nature of pulsation; the patient's sensations on handling the part; the consistence, relations, and connections of any swelling; deviations, either as excess or diminution of normal movement or power of movement, or as presence of abnormal movement or power of movement, as well as any abnormal sensation, such as grating felt by the person examining; the condition of the neighbouring parts, especially such as muscles in joint disease, or lymphatic glands in tumours or inflammation.

2. *Respiratory System.*—Indication of bronchitis, tuberculosis, pneumonia, or other abnormal condition.

3. *Circulatory System.*—Condition of the heart and vessels; pulse, as to number, strength, regularity of beats, compressibility.

4. *Digestive System.*—Condition of the mouth, teeth, and tongue; of the appetite, digestion, and evacuations; state of the liver.

5. *Skin.*—Perspiration, eruptions, cicatrices, pigmentation, temperature.

6. *Nervous System.*—Alterations in motion, sensation, reflex action, or cerebral functions.

7. *Genito-urinary System.*—Micturition, as to frequency and pain; condition of urine (see Chap. xxiv.). (In women, catamenia, children, miscarriages.)

Diagnosis.—Including examination of fluids withdrawn, or of portions cut off for diagnostic purposes, as well as remarks made by the surgeon.

Treatment.—All the measures used in treatment are to be mentioned. If an operation be performed, the operator should be asked as soon as it is finished what description he wishes given of it. The anæsthetic (if any) should be mentioned, and the patient's behaviour under it; also the mode of closing the wound, the drainage, and dressings used, if in any way unusual. For future reference the fluids or tissues removed should be described, and the result of microscopic examination recorded.

Progress.—On graphic temperature charts, the pulse and temperature are to be set down. These are to be noted night and morning in ordinary cases, but as often as every hour or every two hours in bad septic, abdominal, or head cases. Any important change in the patient's condition should be recorded at the time, as well as any alterations in treatment.

Termination.—If in death, its date, cause, and the results of *post-mortem* examination; if in discharge from the hospital, the condition is to be noted, and the date. Should the patient return to report progress, a note of the date and condition should be added to the case, also any change of address if such has taken place.

Illustrative case.—

(Heading.)

Tuberculous disease, right knee—Excision, anchylosis.

Catherine C.

Admitted June 4, 1909.

Operation—June 12.

Sent to Convalescent Home—June 28.

Returned Home—October 16, 1909.

(Case Record.)

Catherine C., aged 28, domestic servant, single.

Address—Comar, Strathmore, by Claynonis. Recommended by Dr. Y., Claynonis.

Admitted June 4, 1909, to Ward Z, Royal Infirmary, Edinburgh, under Mr. Sawyer's care.

Complaining of " a bad knee."

History of Present Disease.—Ten years ago, after a severe cold, the patient noticed a peculiar numb sensation on the outside of her right knee. This continued for some weeks, and was then followed by swelling and pain of a shooting character, which sometimes wakened her from sleep. Six months later the patient went to Claynonis Infirmary, with her knee drawn up and still swollen, although less painful. The joint was painted with iodine, and extension was applied to the leg with the effect, however, at first of increasing the pain in the knee. This treatment was kept up for five months without doing any material good. During another month, fly blisters were repeatedly applied, but also without effect. The patient then went to Strathpeffer for two months, and says that the waters there did her a great deal of good. Next summer she repeated her visit to Strathpeffer, and the summer after that she stayed at the sea-side, where she also got benefit. Since then she has been at home, able for the most part to walk about and work a little, and troubled with pain only when she did too much. Within the last year, however, the knee has grown weaker and more painful, and for the last six months she has only been able to hobble about with the aid of a stick. She has worn a splint from time to time to keep the leg straight.

Previous Health.—Up to ten years ago she was fairly healthy, although troubled from time to time with enlarged cervical glands.

Social History.—Except that she had been a good deal in-doors, her mode of life was satisfactory.

Family History.—Father alive and healthy: mother died in childbirth eighteen years ago. She has four brothers and two sisters alive and strong. One brother died of inflammation of the lungs after three weeks' illness. Two of her aunts, on her mother's side, died of consumption.

Condition on Examination (June 5, 1909).—The patient is a thin, fair, and delicate looking young woman, with a weary, tired expression. She is confined to bed, or the sofa, but can walk a few steps with the aid of a stick and the support of a friend.

Affected Part.—She complains of little or no pain when the limb is at rest.

On Inspection.—The right leg is partly flexed, and lies on its outer side. The knee is greatly swollen, especially at the inner side and round the patella, and measures 2 inches more in circumference than the left. The swelling is not abruptly marked off, and is accompanied by no discoloration. One or two scars, the result of some irritating application, are seen over the joint. The thigh and calf muscles are greatly atrophied as compared with those of the other side.

On Palpation.—The temperature of the right knee is felt to be raised above that of the adjacent parts of the limb and of the opposite knee. There is tenderness on pressure all over, especially opposite the internal semi-lunar cartilage and over the outer tuberosity of the tibia. The swelling is soft and elastic, but without any definite fluctuation. The patella is fixed, and the joint cannot be flexed or extended for more than about twenty degrees without much pain. Distinct lateral movement can be produced, although it is accompanied by considerable pain.

Respiratory System.—She has no cough, but over the apex of the left lung there is some dulness on percussion, and prolonged expiration on auscultation, which gives rise to a suspicion of commencing phthisis; otherwise normal.

The condition of the other systems calls for no special remark.

Diagnosis.—Tuberculous ostitis leading to tuberculous synovitis, which has extended over the cartilages at their margins and has involved the ligaments. Tendency to phthisis at the apex of the left lung.

Treatment.—On June 12 the knee-joint was excised under chloroform by Mr. Sawyer. The whole of the synovial membrane was dissected away along with the patella by A. G. Miller's method, and what remained at the back was scraped and pared with scissors. The sawn surfaces of bone were healthy, except at one place on the outside of the tibia, in which were tubercular granulations. These were gouged out, and the ends of the tibia and femur were then placed in apposition. The usual antiseptic precautions were observed. After the dressing was applied the limb was fixed in a box splint.

Progress.—The case was dressed on the second day when the drainage tubes were removed, again at the end of a week when the stitches were taken out, and for the third time at the end of three weeks when the wound was found quite healed. A day or two afterwards the limb was encased in plaster of Paris, and the patient sent for three weeks to the convalescent hospital. On her return she was sent to the country for two months, wearing

a starch bandage. When this was removed the bones were found to be firmly anchylosed, and the patient went home on October 16 wearing a high-heeled boot. Her general health was much improved.

CHAPTER II.

ON THE TREATMENT OF PATIENTS BEFORE AND AFTER OPERATION.

Contents.—I. Treatment before Operation—Constitutional, Local, Special. **II. Treatment after Operation**—Constitutional, Local. Posture in Bed, Special—(*a*) After Operations upon the Rectum and Anus, for Strangulated Hernia, for Ovarian Tumour, on the Genito-Urinary Tract, washing out the Bladder; (*b*) after Operations upon the Mouth and Jaws—Difficulties in administering Food; how to meet them—Nutrient Enemata—General Hints on Nourishment.

It would be difficult to over-estimate the importance of this subject. For convenience, we may consider it under the heads of Constitutional, Local, and Special Treatment, before operations, and after them.

I. Before Operation.—(1) *Constitutional Treatment.*—It has long been recognised that the result of operations much depends on the patient's general health, and this may be paraphrased into *the efficiency of all the organs under the conditions which follow the operation.* To secure this, some preliminary treatment may often be called for, either (1) to regulate some system or organ, and improve the blood; or (2) to accustom the patient to the fixture and surroundings which must follow the operation.

In many patients a special diet, rest in bed, or particular drugs, may be required to improve digestion, stimulate elimination, relieve congested liver or kidneys, regulate the action of the heart, or improve nutrition. For instance, persons who regularly overload their system with alcohol, keep up the appearance of health for a long time if they are able to take active exercise. Should they be suddenly laid up, however, from a fractured limb or other cause, their health at once gives way. Symptoms of delirium tremens appear, and wounds are exceedingly apt to develop erysipelas or other septic conditions. In such cases preliminary treatment by sparing diet, and diminished allowance of alcohol, laxatives, and rest in bed, would go far to lessen these unfortunate tendencies. In other cases, tonics, iron, and cod-liver oil may be required. In many tuberculous cases a course of tuberculin is a valuable preliminary to an operation, and before operations on the mouth and jaws, some surgeons inject antistreptococcus serum. For a few days before any operation on use of urotropin given along with acid phosphate of soda to render the urine acid.

Where case records are not systematically taken, at least the **heart** and **lungs** should be examined, and the **digestive system** enquired into, the morning and evening **temperature** ascertained, and the **urine** tested. It is better to examine the heart some time before the operation, rather than to add to the patient's alarm by sounding the heart just before the anæsthetic is given.

The **bowels** should be well opened on the morning of the day before the operation, and an enema is advisable on the evening before operation. This enables the patient to rest quietly on the night preceding the operation. Some prefer the free action of the bowels to be two days before the operation. The diet should be light on the day preceding the operation, and no food should be allowed for at least four hours before anæsthetics are administered. In women, no operation that can be postponed should be undertaken during, or immediately before, the menstrual period.

(2) *Local Treatment.*—The area of *skin* which may be covered by dressings should be carefully prepared. All hairy parts should be shaved.

There are many ways of preparing the patient's skin at and near the seat of operation. None is simpler, and none apparently more reliable, than Lister's, described by Hector Cameron as follows :—

"Lister, till he gave up operating in 1896, continued the simple procedure which he had adopted thirty years before; and he informs me that he never had any reason to doubt its efficacy. This consisted of washing the surface freely with a 1 to 20 watery solution of carbolic acid, and keeping it covered with a piece of lint or other cloth soaked with the same lotion during the interval between the washing and the performance of the operation. That interval was never made, by his directions, a protracted one. In private practice the washing was done when he entered the patient's room, and the operation was proceeded with as soon as the instruments had been got ready and the anæsthetic administered. He never took any steps for ridding the skin of greasy impurity or epidermic debris. The great affinity which carbolic acid has for most organic substances, including the fixed oils and epidermis, made any such measures, in his opinion, wholly unnecessary" (*Evolution of Wound Treatment*).

Lister proved by experiment that human hair absorbs in thirty minutes half of the carbolic acid from a 5 per cent. solution in which it is soaked, and applied the fact to practice by omitting to shave the scalp before operations for removal of wens, etc., when he thought it advisable for æsthetic purposes. This property of carbolic acid of penetrating hair may be utilised with advantage in certain cases.

In *cases of urgency* Lister's method, by its simplicity and efficiency, is of special value. Hector Cameron has found it to be applicable to urgent abdominal cases, such as "visceral perforations, ruptures of ectopic pregnancies, and the like." He applies "a large dressing of lint over the whole front and sides of the

abdomen, with a small separate piece loosely packed into the umbilical depression, all throughly wet with a 1 to 20 solution of phenol, and allowed to remain on for at least half an hour." The pubic hair may have to be removed.

As a matter of convenience, many surgeons prefer to have the skin well washed and shaved on the evening before an operation. The part should then be protected with a sterilised cloth, or one soaked in a weak antiseptic lotion, until the 1 to 20 carbolic lotion is applied about half an hour before the operation.

Another simple and equally reliable method is to wash and shave the region to be covered by the dressings, remove the moisture from the skin with ether or methylated spirit, and paint on a 4 per cent. solution of iodine in spirit in one or two coats. When the iodine is dry, cover the part with a sterilised cloth and fix it with a bandage. This may be done with advantage the night before an operation. The sterilised cloth remains in position till the operation is about to begin. When the skin is very sensitive, the iodine may be diluted with an equal part of methylated spirit. Some prefer to protect the skin with a dry sterile cloth after the scrubbing, and to apply the iodine just before the operation.

In *infants* and *young children* it is sufficient to wash well with green soap and water, and then with methylated spirit or 1 to 40 carbolic lotion, just before the operation.

The mucous membranes of surgical patients require attention no less than the skin, although the methods of cleansing and agents employed are different, and vary with the mucous surfaces involved. The reason for aiming at asepsis is obvious when a mucous membrane is included in the area of an operation, as in cleft palate, or other operations within the mouth. But attention is required also for other reasons. A septic condition of the mouth or nostrils may be the cause of sepsis in the parts beyond, in the lungs, for instance, after a general anæsthetic or in distal parts of the alimentary canal. Again, a neglected focus of organismal growth may cause a general toxæmia with or without secondary local manifestations in joints or other parts; such foci might lurk in the mucous membranes of the alimentary canal, or of the respiratory or genito-urinary systems.

(3) *Special Treatment.*

a. Operations about the Face of Men.—The shaving of the hair beforehand is important, as it unduly prolongs the anæsthesia to do this on the operation table.

b. Operations on Tuberculous Cervical Glands.—Sources of irritation or sepsis in the tonsils or teeth should be looked for and remedied, if possible, before operation; also the scalp should be shaved so as to leave the area covered by the dressing smooth. Should the patient strongly object, the hair for some distance round should be well soaked in 1-20 carbolic acid lotion (p. 7).

c. Operations on the Mouth.—Loose teeth should be removed, and carious teeth drawn, stopped, or at least swabbed with pure carbolic acid. The teeth and gums should be well brushed at least twice a day

and the mouth frequently rinsed with Condy's fluid, peroxide of hydrogen, or other antiseptic mouth wash.

d. Operations on the Alimentary Canal.—The mouth should be cleansed as in *c*, and efforts should be made to render the stomach and intestines as free from organisms as possible. Cushing advises that the food for some days before operation should be taken from very clean or sterilised vessels, and should consist of sterilised water, milk, and other fluids in an aseptic condition. Where there is gastritis, and micro-organisms in number in the gastric contents after a test meal, the stomach should be washed out twice daily for some days before operation.

Before an operation for rectal carcinoma, preliminary treatment is necessary and requires at least a week. In order to diminish internal fermentation the mouth must be attended to; careful and thorough mastication of all solid food, aided by the saliva only, is also important. Liquid foods must be sipped slowly; fluids should be drunk not during, but after or between meals.

The bowels must be thoroughly evacuated by a purgative, followed by laxative doses of salines on successive days. When the bowel is relieved intestinal antiseptics should be given by the mouth—subnitrate of bismuth is the drug recommended by Kocher.

Beta-naphthol (grs. 10) is recommended by Tuttle and others. (A course of milk soured by the Bulgarian organismal ferment might prove useful in some cases if time permitted.)

Along with these measures the rectum should be well irrigated two or three times a day with bichloride of mercury (1-5,000), permanganate of potash (1-1,500), or preferably peroxide of hydrogen (one to three or four parts of boiling water); while these various measures are in progress the patient's diet should be largely nitrogenous—meat, strong soups, eggs, and milk, with bread and refined cereals. Food should be given at frequent intervals.

Before operations near the anus, such as those for *hæmorrhoids* or *fistula*, the bowels should be freely opened two days rather than one day before the operation. This will be followed by an enema early in the evening before the operation—not on the same morning—which leaves the bowel irritable and apt to discharge fluid during the operation.

The bladder should be emptied before every operation, but this rule is imperative before any laparotomy involving the lower part of the abdomen and pelvis.

Where plastic operations, involving the transplanting of skin-flaps by stages from distant parts, are to be undertaken, the parts which are to be held in apposition must be fixed in their required place for some days beforehand, so that the patient may be accustomed to the constraint.

II. After Operation.—(1) *Constitutional Treatment.*—After any capital operation the patient is usually kept on fluid diet for a few

days until the effects of the anæstnetic have passed off. When patients complain of much pain, the best analgesic is opium, given as morphia, hypodermically or by the mouth. The amount of the dose will vary with the patient's tolerance of the drug; but it is best to begin with small doses—say $\frac{1}{6}$ of a grain, which may be repeated if necessary. Children, aged people, and those with renal disease or bronchitis, bear opium badly. Heroin acts in a similar way. In sleeplessness, where there is no pain, paraldehyde, bromide of ammonium, chloral, veronal, trional, and hyoscyamus, prove useful. As soon as digestion permits of it, fish or chicken is added to the diet (see *Appendix P*), and, as soon as possible, full hospital diet is ordered. If the bowels do not act of themselves, they should be opened on the third or fourth day by an enema or simple laxative. The tongue, as indicative of the state of the digestive system, should be looked at from time to time. The late Mr. Syme's favourite remedy in liver and stomach derangements was a powder of rhubarb (grs. v.) and soda (grs. v.) given once or twice daily before meals for a few days; to this bismuth may sometimes be added with advantage. Where the liver seems sluggish, a bitter infusion, with dilute mineral acid and tincture of nux vomica, is useful. Iron is often indicated by the anæmic state of the patient, and other remedies may be required according to circumstances.

(2) *Local Treatment.*—The local treatment involves wound-dressings, which are elsewhere considered (p. 30).

(3) *Position of the Patient in Bed.*

Dorsal Position.—The dorsal position is not the most comfortable one, and many patients find it very irksome. Unless there is a good reason for maintaining this position—such as the presence of a fracture of the thigh or a large abdominal wound which cannot be closed and from which intestines might protrude—the patient should be propped with pillows to one side, preferably the right, from time to time. While on the back, a pillow under the knees is often a great comfort.

Prone Position.—Under certain circumstances this is a very valuable one. The patient lies on the abdomen, the chest is raised on one side with a pillow, and the head rests on one cheek so as to keep the mouth and nostrils free.

This position is indicated after operations on the tongue or jaws, when the patient is somnolent after operation, as when morphia, or morphia and scopolamine, have been administered. In this attitude, if oozing takes place, the blood escapes by the mouth, while it is apt to be inhaled if the semi-conscious patient is lying on his back.

Other indications for the prone position are to improve the drainage of an abdominal or pelvic abscess, or to relieve the back when there are bed-sores.

Raising the Foot of the Bed—See Treatment of Shock, p. 81.

The Half-sitting-up or Fowler Position is indicated in the after-

treatment of cases of general or pelvic peritonitis. The body is raised at an angle of from 30° to 50° from the bed and the knees are flexed. Fluids in the abdomen gravitate into the pouch of Douglas and escape by a drainage tube or wick of gauze left there for the purpose.

As the patient, if weak or heavy, is apt to slide down from this position, some mechanical support under the thighs is necessary. A bolster, or a stick with a blanket wrapped round it, may be placed under the thighs, but the ends of either appliance must be securely fastened to the head of the bed.

A more reliable and efficient plan is to adapt a special frame to the bed, such as that recommended by Gatch of Baltimore. This "consists of an oblong frame of stout boards, to the upper surface

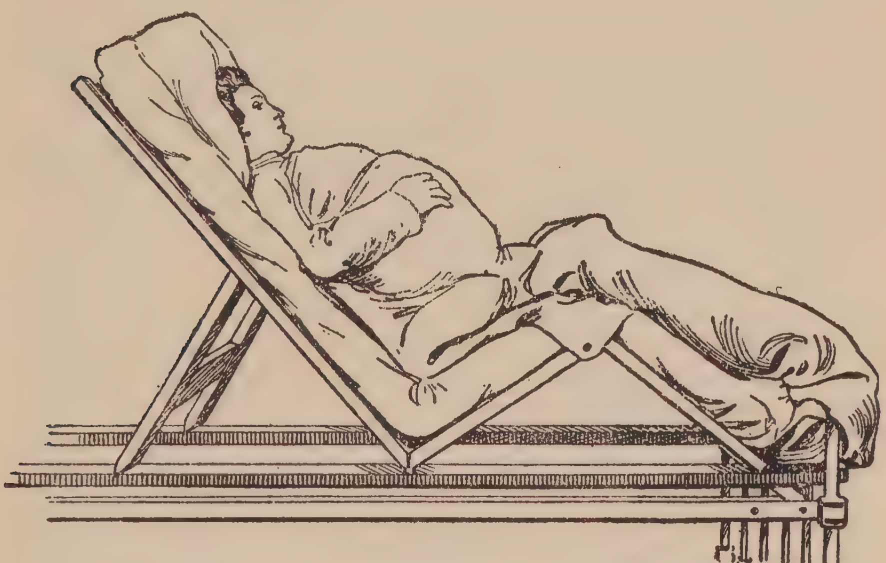


Fig 1.—Bed Rest for the Sitting Position. (After Gatch, *Annals of Surgery*, vol. xlix.

of which are hinged three movable flaps. The frame is of the exact length and width of a standard ward bed, on the springs of which it is intended to rest. . . . The flap which supports the trunk should be about 36 inches long; the smaller flaps should be 14 to 16 inches long" (see Fig. 1). A similar frame may be made of iron and attached to a special bedstead. The patient rests on a flexible or a hinged mattress, covered with waterproof sheeting when necessary.

Gatch recommends the bed-frame in the following cases:—*Operative.*—(1) Where drainage of the peritoneal cavity is required. (2) Where there is a risk of pulmonary complications, as in stout people who have undergone operations in the upper part of the abdomen, in cases of laparotomy followed by distention, and in

elderly and feeble people with cardiac weakness, or with bronchitis and emphysema. (3) Where drainage or continuous irrigation of the bladder is required—supra-pubic or perineal; also in cases of infection, or burns of the thighs, genitalia, or abdomen, and in caring for patients with incontinence of urine or fæces. The shoulders being raised, the patient's buttocks rest on a Kelly's pad or sheet, and the fluids gravitate downwards and are drained off.

Non-operative.—In orthopnœa from heart disease, in pneumonia and asthma, and as a change from the lying posture for most patients.

(4) *Special Treatment.*—(*a*) *In all cases of operation upon the* anus *and* rectum, such as for fissure, fistula *in ano*, or piles, the bowels should remain unopened for about two days, and be opened on the third morning by castor oil or other mild aperient. The free opening of the bowels before the operation, and the low diet after it, generally suffice to keep the bowels from moving of themselves for some days. When morphia suppositories have been given to soothe pain after the operation, the bowels will be still more bound. It is better not to wait until the bowels move of themselves, because by that time firm fæcal masses will have formed. These would be more irritating to the recent wound than the earlier passage of a liquid stool. An enema may be used if carefully administered.

It should be remembered that operations upon the anus, and in the neighbourhood of the urethra, are apt to cause retention of urine by reflex spasm of the constrictor urethræ. Some surgeons on this account pass a catheter at the end of the operation, and in any case provision must be made for drawing off the water within eight hours of that time, and for repeating the proceeding if need be. In the case of men, it is often possible to avoid the use of the catheter by allowing the patient to stand up to pass water.

(*b*) The treatment of the bowels after the relief of a strangulated hernia, whether by taxis or by operation, is a matter of dispute. Some surgeons invariably administer opium or morphia, and keep the patient on low diet, to prevent any motion of the bowels for a week or ten days. This is done to insure rest for the injured and probably inflamed bowel, and may in some cases be necessary. Other surgeons act on the principle that if the bowel be inflamed, its peristalsis will be thereby checked, so that unless local pain or general restlessness call for the use of opium, it may be omitted, and the action of the bowels left to nature. The latter seems the more rational plan, and is the one which we advocate.

Where it is known that the bowel itself is injured, efforts will, of course, be made to ensure absolute quiet for the injured part, opium or morphia continued for a week or ten days, and the patient fed by nutrient enemata, supplemented only by small quantities of fluid food given by the mouth.

(*c*) After **Ovariotomy**, or other intra-peritoneal operation, the general indications are to keep the parts at rest and avoid sickness, and to give the patient as much fluid as possible, at first by the rectum for fear of sickness, and afterwards by the mouth. The more fluid the patient absorbs the less the risk of shock and the less suffering from thirst, and the greater the elimination by the excretory organs, and yet with a less concentrated and irritating urine. From 3 to 8 ozs. of normal saline may be slowly injected per rectum at a time. If this be repeated, thirst will be quenched (see *Murphy's method*, p. 80). After flatus has been passed, as it usually is twenty or twenty-four hours after operation, the diet is gradually improved, beginning with milk and water. Nutrient enemata may sometimes be required, should tendency to vomiting continue (see p. 24). Unless specially contra-indicated by the state of the intestine, distention of the bowel with flatus should be treated by purgatives. Calomel is given, generally in 1-grain doses, until 3 or 4 grains are taken, and this is followed by a seidlitz powder or by sulphate of magnesia. If the bowels do not move spontaneously in two hours, an enema should be administered. The whole may be repeated once.

After all abdominal operations flatus in the rectum is apt to cause discomfort, because the patient cannot well strain to get rid of it. Any wide tube occasionally passed gently into the rectum will allow the flatus to escape, while a soft rubber catheter or a special "flatus tube" may be allowed to remain *in situ* for some hours at a time.

Sometimes a "flatus enema" will give relief. This consists of 1 oz. Henry's solution (magnes. sulph., oz. vj., acid sulphuric dil., oz. ½; distilled water up to oz. xij.), 1 oz. of glycerine, and 2 ozs. of water.

(*d*) *Operations on the* **Genito-Urinary Tract.**—The chief point to be attended to in the after-treatment of patients whose genito-urinary tract has been operated upon, is to diminish the acidity of the urine and lessen the work of the kidney by keeping down the albuminoid element in the food. A diet, consisting chiefly of milk and starchy foods, is best for this purpose. When the kidney has been injured, the bowels must be kept open. Fœtid urine may be improved by the free administration by the mouth of boracic acid (½ oz. sat. solution every three hours), salol (15 grs. twice or thrice a day), helmitol, quinine, sandalwood oil or copaiba, and, best of all, urotropin, as well as by the injection of weak antiseptics into the bladder.

Washing out the Bladder is often of great service when the urine is purulent, and the mucous membrane unhealthy. Some surgeons use a double-way catheter. With this instrument, fluid is injected by one of the channels, while it flows out by the other; but, as by this method the mucous membrane is not distended and its folds exposed to the fluid, we prefer the ordinary single-way catheter.

The fluids at first used must be warm (80° to 100° F.) and

unirritating antiseptics—*e.g.*, 1-4,000 corrosive sublimate lotion, half strength boracic lotion, or 1-200 carbolic acid; quinine 2-3 grains per ounce, with 1 min. dilute sulphuric acid per grain; nitrate of silver $\frac{3}{4}$ to 1 grain to ℥i, or $\frac{1}{2}$ per cent. formalin solution.

The *quantity* of fluid injected must depend on the state of the patient's bladder—such as can be borne without much inconvenience.

The meatus and glans penis must first be cleansed with an antiseptic lotion. When the urethra or bladder is irritable, Novocaine or Eucain (2 to 5 per cent.) may be utilised. A catheter (soft for preference) is passed into the bladder, and the urine drawn off. The selected fluid is then injected with a syringe (Higginson's, a ball, or an ordinary piston syringe), or is allowed by syphon or water-head to flow in from a height of 1 or 2 feet at most. The catheter may be connected with the syringe with a small piece of rubber tubing, but a finely conical nozzle at the end of the syringe will suffice. The fluid is then allowed to escape, and is probably at first turbid; the process is repeated until the returning fluid is clear. The simplest method of washing out the bladder is to connect a small glass or metal funnel with the catheter in the bladder by means of 3 or 4 feet of rubber tubing. The tubing is flushed to warm it and drive out air, and is then clamped while the connection is being made. The funnel is raised about 2 feet above the bed while the fluid runs into the bladder. When sufficient has entered, the funnel is rapidly lowered to a pail below the bed to syphon out the fluid. This is repeated until the fluid returns clear. In washing out the bladder *in women*, Burn Murdoch's plan seems the best. The patient's hips are brought well to the edge of the bed, while her body lies obliquely across it. If the lower parts of the labia majora be now separated the orifice of the urethra can be seen and the catheter inserted, with very little idea of exposure to the patient. The bladder is then washed out.

(*e*) *Operations on the* Mouth *or* Jaws.—After extensive operations in this region, the difficulty of feeding the patient may be considerable. Mastication is generally impossible, and swallowing nearly so, as well as painful.

Frequent cleansing of the mouth with Condy's fluid or boracic lotion is a source of great comfort to such patients, and is very important in restraining sepsis. A nurse may syringe the parts freely, at least three or four times daily, or a syphon with clamp or stopcock may be laid close to the patient's bed, so that he may himself wash out his mouth as often as he pleases.

Difficulties in Administering Food: How to meet them.—Under these circumstances, liquid food must be administered (*a*) *through a tube by the mouth*, or (*b*) *per anum.*

(*a*) Sometimes at the end of the operation, a gum-elastic or soft rubber catheter (about Nos. 12 to 18) is passed either through the nostril or the mouth into the œsophagus, and is held in position by

a stitch. In other cases the House Surgeon or nurse passes a similar tube each time the patient is fed. The food, which must be poured through a funnel raised a few inches, will generally consist of milk, beaten-up eggs, beef-tea, thin arrowroot, and (if necessary) alcohol in the form of brandy or whisky. It is needless to say that, if a tube has to be daily passed, care must be taken to ensure that it enters the œsophagus and not the trachea. It has happened that the patient's lungs have received the food meant for the stomach—an accident which involves nearly certain death, either by immediate suffocation or rapid pneumonia.

(b) *Rectal Alimentation* is at best a poor substitute for feeding by the mouth. Life may be sustained by it, however, for several weeks and even months; and in certain circumstances the rectum becomes the only available channel for introducing nourishment into the system.

The physiological facts on which the proper management of rectal alimentation depends, are briefly: that while the *absorptive* power of the large intestine is very great, *digestive* powers may be considered to be wanting in its juices altogether; and that in virtue of its expulsive function fluids or solids introduced per *anum*, large in amount, or with irritating qualities, will be expelled before absorption can occur.

Nutrient Enemata should, therefore, be pre-digested, should be small in amount (from 2 to 6 ozs.), should be injected slowly, and as nearly as possible at the body-temperature (95° to 100° F.). Under favourable conditions, a reverse peristalsis seems often to occur, and the materials of enemata injected shortly before death have been found afterwards at the cæcum.

The *food injected* should be (1) peptonised albuminoids, in the form of peptonised meat-juices sold ready for use (Johnston's, Darby's, Brand's, etc.); beef-tea, or white of egg, digested with pepsin and hydrochloric acid, or more conveniently with Benger's Liquor Pancreaticus, or some of the peptonising powders sold by chemists (Fairchild's and the zymine powders sold by Messrs. Burroughs & Welcome act admirably); (2) diastased starch in the form of prepared malted foods, or starchy foods acted on by malt extract, or by artificial pancreatic juice; (3) or the combination of starchy and albuminoid foods contained in peptonised milk, or peptonised milk-gruel (see also *Appendix*).

N.B.—Huter seems to have established by experiment, that the mixture of a gramme (15 grs.) of common salt with the white of each egg renders the albumen almost as ready for rectal absorption as peptonising does. This method from its simplicity will be of much practical use.

Peptonised suppositories are a convenient form by which albuminoid substances may be administered.

To lessen the irritability of the rectum, all fæcal matter should be cleared out from it by an enema of warm water, with or without

soap, before rectal alimentation is begun, and from time to time during its progress.

The same care in maintaining an excess of carbohydrate over albuminoid food (in proportion of about 4 to 1) must be taken in dealing with this, as with the ordinary mode of feeding by the mouth.

Nourishment: General Hints on.—Speaking generally, the nourishment of patients recovering from an operation is to be maintained on the principle of giving nutrition without increasing the nitrogenous waste. Beef-tea, chicken-broth, and other meat-infusions are recognised as stimulants to tissue-change rather than foods proper. They should not be omitted; but starchy foods should be chiefly relied on, and it should be remembered that meat-infusions alone will cause more rapid wasting than no food at all.

In *feverish conditions* (septic and otherwise) the digestive juices lose their power—hence the indication for giving artificially-digested foods in extreme cases. When the mouth becomes dry and parched for lack of saliva, arrow-root, rice, and other starchy foods are contra-indicated, unless previously acted on by malt or pancreatic extract (*Chambers*). In these cases the use of artificially prepared foods specially intended for infants will be found of service. The various kinds seem to have this in common, that they contain starchy foods more or less changed by malting (Mellin's, Angell's, and Savory & Moore's, can all be highly recommended).

CHAPTER III.

ANÆSTHETICS: GENERAL AND LOCAL.

Contents.—The condition suitable for Operation—Importance of Personal Experience in the Administration of Anæsthetics—(1) Chloroform: Mode of Administration—Dangers and Cautions—Respiratory and Cardiac Complications: how to meet them—(2) Ether: Administration of (*a*) by the "Open," (*b*) by the "Closed," Method—(3) Cocaine—Caution!—(4) The Method of producing Local Insensibility by Extreme Cold.

THE drugs most commonly employed for the production of general anæsthesia are chloroform and ether. No anæsthetic can be regarded as absolutely safe. The relative safety of the various agents employed depends upon the administrator, the condition for which the anæsthesia is required, the patient, and the anæsthetic.

Stages in Depth of Anæsthesia.—In an uncomplicated case it is usual, as Hewitt points out, to recognise four stages of

anæsthesia, if the anæsthetic be steadily pushed. In some particulars the effects of chloroform and of ether are different, ether being more of a stimulant, but in general terms the stages may be described as follows, their boundaries being ill-defined :—

(1) *Analgesia.*—Mental faculties disturbed and confused, self-control and memory of sensations diminished; sense of pain deadened or abolished, although sense of touch remains; reflexes exaggerated, respiration and action of heart increased, pupils dilated.

(2) *Light Anæsthesia.*—Consciousness lost, patient mutters, rambles, or is delirious, muscles thrown into spasm, tonic at first then clonic; in consequence trouble often arises from clenching of jaws, contraction or closure of the glottis, imperfect and irregular breathing, stiffness and irregular, sometimes violent, movements of the limbs. Respiration in itself is stimulated, so also is the heart's action, but if respiration be impeded the heart suffers from the obstructed pulmonary circulation; pupils smaller.

(3) *Deep Anæsthesia or Narcosis* is the stage suitable for most operations, and is the one usually indicated by the expression the patient is "under." Muscles become relaxed, respiration regular, often deep. Heart dilates and its action is weakened (especially with chloroform), blood pressure falls (chloroform); most reflexes disappear, such as those of patella, eyelid, pupil, pharynx, and larynx, as the stage advances. Those of respiration remain. Pupil larger, although still less than normal. The later phases of this stage are dangerous.

(4) *Bulbar Paralysis,* in which there is imminent danger to life followed by death. Sphincters of bladder and rectum relax, respiration becomes shallower, its reflex diminishes, later on it ceases. Heart's action becomes feebler and more irregular, but continues after respiration has ceased. All reflexes cease; pupils widely dilated and immobile; eyelids half-open; face increasingly pale and livid; death.

The anæsthetist's object is to conduct the patient as speedily as is consistent with safety into stage 3—*i.e.,* narcosis—and he should bear in mind that there is as much risk in prolonging stages 1 and 2 unduly, as in forcing the patient through them too rapidly Apart from the anæsthesia, there is also a risk in allowing a painful operation to begin during "light anæsthesia," in which stage a reflex depression of the heart and respiration from a strong afferent stimulus is believed to be considerable in certain cases. Hence, the administration of an anæsthetic involves grave responsibilities, requires the undivided and unceasing attention of the administrator, and should only be carried out by a student in the presence of a qualified practitioner who is a skilled anæsthetist. Although the risk which attends the *careful* administration of chloroform or ether is but small, it is difficult to exaggerate the perilous position of the patient, where due care is *not* exercised.

The student should seize every opportunity of giving anæsthetics, as nothing short of actual experience can give him the necessary knowledge and skill.

How to recognise the Depth of Anæsthesia.—It is of great importance for the anæsthetist to be familiar with the features of the successive stages in anæsthesia, as only then can he tell whether to get rid of a troublesome condition by increasing or by diminishing the dose. Besides maintaining a general outlook on the patient's condition, the anæsthetist watches the respiration closely, especially when using chloroform, and jealously guards against any infringement of a "free-air way." In deciding as to the patient being "under," he is helped most by the regularity of breathing, relaxation of muscles, and the state of the reflexes of the eyelids and pupil. The lid reflexes are closure responses of the lids to stimulation of the cornea or conjunctiva. They are distinguished respectively as the corneal and the conjunctival reflex. If the upper lid be raised and the surface of the cornea (more sensitive) or conjunctiva be lightly touched, the lids respond by closing. Two fingers may be employed or only one. In the latter case, the pulp of the finger gently everts the eyelashes, raises the upper lid, and then touches the desired part of the globe. The pupil reflex may be tested in several ways, one is by closing both eyelids and suddenly opening one in the presence of strong light. The pupil will contract if the reflex be present. (*N.B.*—This test is not reliable after injection of morphia or atropia.)

At the beginning of a cutting operation the lid reflexes should be abolished. Whether they be allowed to return afterwards or not depends on circumstances. Vomiting does not occur if patient is in "deep anæsthesia," and seldom occurs before the operation unless when stages 1 and 2 have been unduly prolonged.

(1) **Chloroform** is more potent and dangerous than ether. By far the greater number of accidents which occur with it are due to an overdose, to lack of care on the part of the giver. In poisoning from chloroform, it fortunately happens that the respiratory centres are usually involved before the cardiac, and hence embarrassed or shallow breathing—which we can readily obviate—foretells immediate danger, and gives rise to the primary rule—"Watch the breathing." Very rarely does the heart stop first, or suddenly, without warning. This does, however, happen. It has been associated with operations in the region of the fifth and pubic nerves, when the patient was not deeply under the influence of the drug, with epilepsy, and where special idiosyncrasies may have existed. Chloroform is contra-indicated in cases of weak, irregular, cardiac action—be the cause of this what it may—fatty heart, anæmia, shock, fear, depression, or old age.

Previous Preparation of the Patient.—The bowels should be well opened on the morning before the operation, followed by an enema in the evening, the diet should be light, and the patient

should, if possible, rest in bed. The stomach should be empty, no food having been allowed for three or four hours, and only thin soup, tea, and toast, or similar light food, then.

The patient should have nothing loose in his mouth which could pass the fauces, hence teeth likely to fall out, small plates of artificial teeth, sweetmeats or plugs of tobacco, etc., should be removed. Full plates of teeth may be left. Gags, sponges, and mouth instruments should be examined lest any part become loose. Everything possible should be done to allay the patient's anxiety. He should not see the operating-room, or the preparations for the operation. The preliminary injection of morphia with or without scopolamine is of great value from the psychological point of view, besides its value in other ways (see p. 22).

Mode of Administering Chloroform.—The more simple the apparatus used by the chloroformist, the better. A small towel or simple mask, a gag, a pair of common artery forceps (Fig. 21) to pull forward the tongue should occasion arise, several pieces of gauze or small sponges, with two or three volsella or sponge holders to clear mucus from the fauces, also a hypodermic needle and ether or strychnine for emergencies, constitute his requirements.

The drop method has the merit of economy to commend it, and is generally preferred. A single ply of the corner of a towel or a Skinner's mask is held over the nose and mouth on which the chloroform is received *guttatim*.

The folded towel possesses the advantage of allowing one to study the face and feel the breathing directly. It should be folded into a square, and about an inch of its margin turned up so as to form a pad or roll, which may be laid against the chin, and kept free from chloroform. The administration should be conducted on a suitably long narrow table. The head and shoulders of the patient are preferably to be on a lower level than the pelvis and lower extremities, so as to favour a plentiful supply of blood to the vital centres. Under no circumstances should the shoulders be raised, and the dentist's chair, which permits this, is to be condemned for use with chloroform. The patient should lie on his back, with the head comfortably supported and turned well to one side, and all clothing constricting the neck, chest, or abdomen should be loosened. The upper extremities should be perfectly free, but the feet and ankles may be secured to the foot of the table after he is "under." A dram or two of chloroform, not more, is now to be sprinkled over the towel if this method be employed; the patient is told to breathe easily and close his eyes, and the towel is gradually raised in front of the face. If the patient feel uneasy, or if he should complain of choking, the towel should be withheld for a moment till a full inspiration of pure air has been taken. If there be an accumulation of saliva in the mouth, he is asked to spit into a towel. As soon as the patient is unconscious,

a piece of gauze should be placed between the cheek and the teeth, well back on the dependent side, with the end hanging out of the corner of the mouth. This leads out the saliva, and so prevents its accumulation in the mouth. Quiet should always be maintained, since the sense of hearing is sharpened by chloroform, and since the period of excitement which ushers in chloroform-narcosis is often increased by external agencies. Should the patient become greatly excited, it is not advisable to struggle against him. On the contrary, he should be allowed to grasp the hands of an assistant, who will follow and guide his movements. Securing the patient to the table before he is "under," or other restraint of any kind only provokes resistance.

In some people, more especially in drunkards, the stage of excitement is often prolonged. The patient struggles and holds his breath, the veins become congested and turgid, and a species of tetanic spasm sets in, during which the respiratory muscles are apt to become fixed. Under such circumstances the anæsthetic should be cautiously continued in diminished doses, by holding the towel or mask further away or by adding less chloroform. The dose must be increased again by degrees, and, if a sudden gasp for breath takes place, a greater dilution of the anæsthetic with air is all the more necessary. After a fit of struggling the patient often passes very quietly "under," hence the need for caution. It should be remembered in this connection that the effect of one breath of anæsthetic vapour is not observed until one or more subsequent breaths have been taken. As soon as the patient rests quietly, and no longer responds to pinching, his limbs lying limp and motionless, the lid reflex should be tested as already described (p. 18). If the patient does not wink, the chloroform should be at once withdrawn, the patient is "under," and the operator may begin. Throughout the whole administration the breathing must be carefully observed. This may be done by listening and by holding a couple of fingers or the hand in front of the nose or mouth to feel the respiration. Note that the chest may heave although no air is entering the lungs; hence the necessity for *feeling* the breath with the hand over the mouth. At short intervals more chloroform should be given, as signs of returning sensibility are recognised. The cornea should not be fingered too much, lest its sensibility become impaired, and the delicacy of this test be lost. It sometimes happens (as, for example, in children) that the conjunctiva is of little use as a guide, in which case the local sensibility and muscular relaxation will serve instead. When the patient is "under," the pupil is contracted; it dilates and resumes its reflex to light as he recovers, but we must bear in mind that also during profound and dangerous anæsthesia it rapidly becomes widely dilated, and has no light reflex.

Dangers and Cautions.—Certain troubles and dangers are apt to embarrass the chloroformist. These are, firstly, *respiratory*

—the sudden, or gradual stoppage of breathing; secondly, *cardiac*—syncope, or complete cardiac failure.

(*a*) **Respiratory Arrest**, when *sudden*, is frequently due to some foreign body in the mouth passing backwards and lodging in the larynx, (see p. 19, "previous preparation of patient"). The tongue itself may suddenly fall back, and so obstruct respiration. If so, by pulling the chin *forward*, and turning the head slightly on one side, the tongue is prevented from becoming an impediment; and if the condition does not at once yield to this simple manœuvre, the mouth should be opened and the tongue drawn forward with forceps; should this fail the glottis must be explored with the finger.

Gradual stoppage of breathing is usually associated with over-dose. In poisoning of the respiratory centres, the breathing becomes shallow, irregular, and laboured—all of which signs are evident enough to the attentive administrator. Or, again, there may come on closure of the glottis, associated with crowing, "croup-like" breathing, which at once gives the alarm. The treatment is to open the mouth, which may entail the use of the gag. The tongue is then forcibly seized with the artery forceps about half an inch from its tip, and they are closed, so that slipping is impossible, and the tongue is then pulled *forcibly* forwards and upwards. This causes the glottis to open, and reflexly stimulates respiration. The tongue is, of course, pierced by the forceps, but less damage is inflicted than by the various inefficient substitutes which have been recommended. *In every case where there is no response to this treatment, artificial respiration* should be at once carried out.*

Sickness and vomiting are dangerous from the risk of ejected material gaining access to the air passages. This is very liable to occur during operation for intestinal obstruction. A preliminary washing out of the stomach gives the patient relief, and may obviate this disaster. Intermittent administration, shaking and movement of the patient, favour sickness. If the stomach contain food or fluid, the patient should be turned bodily on his side and allowed to vomit, after which the chloroform is again resumed. If it be empty, chloroform is pushed in order to abolish the reflex act.

Tracheotomy for asphyxia during anæsthesia is rarely necessary. It may be called for owing to the impaction of blood, vomited matters, or when a tooth or other foreign body lodges in the larynx. It may be required when ordinary means fail to open the glottis.

(*b*) **The Cardiac Complications** are, in the first place, those associated with, and secondary to, difficulty of breathing, when the right heart becomes distended and general congestion occurs. We have already alluded to this, as seen in the case of drunkards. It is enough to remove the towel and encourage respiration. In anxious cases, the external jugular vein may be opened; or, if the heart have stopped, the right ventricle might, as a last resort, be punctured with the hypodermic needle, blood withdrawn, and the endocardium at the same time stimulated. Syncope is presaged by pallor, feebleness, and irregularity of the pulse, which,

* Artificial respiration after the method of Sylvester (see p. 98).

if not relieved by ether (ʒi) or strychnine ($\frac{1}{40}$-$\frac{1}{60}$ gr.), hypodermically injected, or by substitution of ether inhalation for chloroform, is speedily followed by extreme pallor, sudden dilation of the pupil, and cardiac failure. The most prompt action is necessitated in such cases. We have to stimulate the bulbar centres by lowering the head, and the method of *inversion*, which we owe to Nelation, is of great value, since it not only increases the blood supply to the brain, but also opens up the glottis effectually. It is best accomplished, if the patient's ankles are already secured, by tilting the table, or by the operator mounting a chair, and placing his left leg on the table, while he lifts the patient and lays him across his left knee, so that the chest and head are dependent. The anæsthetist pulls out the tongue and begins artificial respiration, while an assistant injects ether or strychnine hypodermically, and makes himself generally useful. If air passes freely into the lungs, we do not lose hope, but persevere with artificial respiration.

It will be noted how much can be learned by watching the aspect of the patient's face. The pallor of syncope and sickness, the congestion of respiratory embarrassment must be well watched, in contrast with the normal colour of the lips and ears. To sum up: we expect that no operative procedure whatsoever should take place till the patient is fairly "under"; that as soon as he *is* under—as evidenced by the muscular relaxation, cutaneous insensibility, and loss of conjunctival reflex—the anæsthetic should be at once lessened or removed; and that in the event of any respiratory trouble arising which is not *at once* relieved by pulling forward the chin, or by briskly rubbing the lips with a towel, or by forcible traction on the tongue with artery-forceps, the alarm should be given, and artificial respiration promptly begun, with the patient's head and shoulders well lowered (Fig. 35).

Junker's apparatus is serviceable for the continuous administration of chloroform during mouth operations. The vapour may be pumped along a tube into the throat, or the modified Mason's gag, with its hollow handle for connection with Junker's inhaler, may be found still more convenient.

Mixed Anæsthesia.—This term indicates the employment of certain drugs as adjuvants to general or local anæsthetic agents. The objects in view are to allay anxiety before operation, to sooth pain and ensure sleep after it, to diminish excitement in the early stages of anæsthesia, to induce analgesia with a minimum of the general anæsthetic in the later stages, and, in the case of atropia, to protect the heart against reflex inhibition through the vagus, whilst also restraining oral and bronchial mucous secretion, which is especially liable to occur when ether is used. The three most important of these drugs are Opium and its derivatives, Scopolamine and Atropine. Others which should be mentioned are Veronal, Chloretone, Chloral, and Bromide of Potassium.

Caution.—Morphine in conjunction with ether, and still more with chloroform, is prone to produce respiratory paralysis. Hence the dose must be relatively small lest inadequate respiration should delay induction of anæsthesia, cause marked cyanosis, or endanger life.

The eye reflexes cannot be depended on as guides when the three chief drugs are in action. It is wise to test the patient's susceptibility beforehand.

For most adults $\frac{1}{6}$ gr. of morphine given about an hour before operation is sufficient. With it may be combined scopolamine ($\frac{1}{150}$ grain) as a mental sedative and hypnotic, and atropine ($\frac{1}{120}$ grain) for the purposes just stated (one or both). Some prefer to give the drugs in divided doses.

Omnopon, a new preparation (Hoffmann-la-Roche Co.) of opium and about five times stronger, is said to contain all its active principles in a pure form. It is better than morphine, in having a less depressing effect on the respiration, and in causing less after-depression and sickness. The Hoffmann-la-Roche Co. issue ampoules containing $\frac{2}{3}$ grain of omnopon combined with $\frac{1}{150}$ grain of scopolamine. The contents of one of these given about an hour before an operation has been found to act very well. In most cases the patients drop off to sleep, and are not conscious of being taken into the anæsthetising room. After the operation they usually sleep for six or eight hours, and when they awake are agreeably surprised to find that the operation is over.

Caution.—Adrenalin and chloroform when combined are dangerous, hence use ether if a solution containing adrenalin has been injected, and proving insufficient requires to be followed by a general anæsthetic.

Chloroforming to facilitate further operative procedure after a preliminary tracheotomy.—To one end of a short piece of rubber tube attach a filler, to the other the inner tracheotomy tube. Chloroform is poured in on a piece of lint at the bottom of a tumbler, the tracheotomy tube inserted, and the filler held over the tumbler. The shorter and larger the tube the greater the ease in breathing. A Junker's apparatus may be used for the same purpose.

Certain disadvantages are apt to attend the administration of chloroform in small rooms with exposed gas or paraffin-oil lights. A decomposition of the vapour takes place and intensely irritating chlorine products are formed.

The well-known inflammable nature of ether also calls for caution when it is used by night, or in proximity to a naked light or glowing cautery. All operation theatres should have covered or electric illumination.

(2) **Ether** is a much safer anæsthetic than chloroform, chiefly because it acts as a cardiac and respiratory stimulant, and because from its greater volatility it is more rapidly eliminated from the blood. Fatalities under its use do, however, occur.

The administration requires the same care and observation, and is carried out much on the same lines as have been indicated under the head of chloroform.

As a rule, the stage of excitement is more pronounced, the face shows congestion, and the administration requires to be more continuous than with chloroform.

Ether may replace chloroform, and is to be preferred, unless the latter is indicated. Chloroform is better in cranial surgery, since it does not congest the brain, and is said to be less irritating than ether in pulmonary conditions. There are two methods of giving Ether—the "Open" and the "Closed" methods.

(*a*) *The "Open" Method.*—This method ensures a free access of air with every breath. It has two varieties, one in which the incoming breath does not all pass through the mask, the other ("perhalation system") in which the margins of the mask are packed off with gauze. The latter is the one usually understood as the "Open Method." Round the patient's nose and mouth is laid some folded gauze on which the mask rests; more folded gauze is fitted round the edge of the mask, over which several layers of gauze are stretched. On this the ether is *continuously* dropped at a rapid rate. Hewitt advises that the dose should begin mildly with the simple mask, and be steadily increased as the change is made to the "perhalation" method just described, unless the anæsthesia is initiated with some other anæsthetic as chloroform, which is a better plan.

Open Method with Chloroform and Ether.—The patient is brought just to the stage of unconsciousness with chloroform and anæsthesia maintained by the continuous-dropping method. As a general routine, this procedure may be strongly recommended.

(*b*) *The "Closed" Method* possesses the peculiarity of requiring that the patient should, to a certain extent, breathe and rebreathe his own expired air; less ether is required, and there is not so much chilling of the lungs. It is carried out by means of a special inhaler—*Ormsby's* or *Clover's* being commonly employed.

Such inhalers consist of a mask or face-piece, to which is affixed a rubber bag, into which and from which the patient breathes. There is an interpolated chamber or sponge for ether, so that the respired air is thus charged with the anæsthetic. The air-pad of the face-piece should be blown up and soaped, if the patient possess a beard, so that it may securely fit when pressed down firmly on the face. In the case of the Clover's inhaler, the ether-chamber is charged with a measure of ether, and the index turned so that the patient breathes and rebreathes into the rubber balloon. After one or two respirations the administrator gradually turns the index so that ether is admitted, and by degrees the air breathed is charged with ether vapour in increasing proportions, the face-piece being closely pressed down. By means of a valve a little fresh air may be given when necessary, but this is most readily accomplished by removing the face-piece. It is noteworthy that, during the administration of ether by the closed method, as contrasted with that of chloroform, the breathing is more noisy and stertorous, there is a copious secretion of saliva, the face is apt to become congested or dusky unless the anæsthetist is careful to give sufficiently frequent breaths of air, and, especially during operations on the head, there is freer bleeding.

Sickness after anæsthetics, when obstinate, may be treated by giving the patient hot water to drink, or by the administration of $\frac{1}{8}$ grain of morphia in pill, with perhaps a little cocaine; tincture of iodine 1 min. to 1 drachm of water, given several times, at intervals of two hours, is sometimes useful. A sinapism over the stomach often gives relief. Oxygen inhalations and rectal salines have been advocated. Troublesome, and even fatal, *diarrhœa* has sometimes been seen after chloroform in the case of little children. The condition of the *urine* before and after anæsthesia should be

noted. Albumin and fibrinous casts or sugar are frequently present thereafter. In kidney disease or diabetes the patient is accordingly liable to suffer, and in the latter case fatal acetonuria may be determined.

Post-Anæsthetic Toxæmia (post-operative acetonuria) may prove a fatal sequel to the use of choloroform, or to that of ether, although more rarely so. It has been observed in the case of children mainly, even after trivial operations. The symptoms vary in extent, but in well-marked instances begin from twelve to forty-eight hours or more after the administration, and take the form of intractable vomiting, thirst, restlessness, delirium, and coma. The urine is scanty. A characteristic smell of acetone may be present in the breath. Treatment consists of purgation. the exhibition of sodium

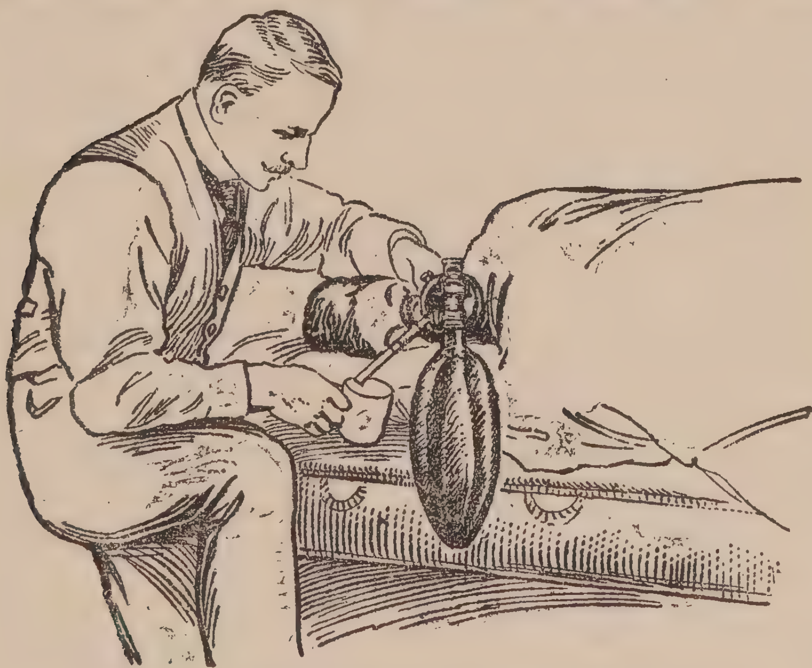


Fig. 2.—Dr. Gibbs' Method of giving Ethyl Chloride.

bicarbonate by mouth and rectum. The stomach should also be washed out with the same drug, leaving some of the solution in.

Prophylaxis is most valuable. Patients who have acetone in the urine should have a course of glucose or sodium bicarbonate. In the case of children, 10 gr. sod. bicarb. every four hours. Glucose (1 drach. for adults, 10 grs. for young children) is given four hourly for 12 doses, the last four hours before operation.

For minor operations requiring a short anæsthesia, especially for dental surgery, also as a means of induction to be followed by ether or chloroform or a mixture of these, the use of *gas* and *ether* may be strongly recommended. For dental purposes it is preferably administered with the patient sitting upright, provided it be not followed while the patient remains upright by chloroform or any mixture containing it. The usual rubber bag and stopcock of a nitrous oxide apparatus is fitted on to a Clover's inhaler, charged with ether.

The bag is filled two-thirds with nitrous oxide, and the face-piece well pressed down over the mouth and nose so that no escape can occur. The gas alone is now turned on, and as the patient rapidly passes under its influence, in about twenty seconds, ether is added and its action maintained until complete anæsthesia is produced.

Ethyl Chloride, or preparations thereof, are also extensively used for anæsthesias lasting one and a-half minutes. If need be the dose may be repeated. Not more than 5 c.c. are sprayed into the bag of a Clover's or special inhaler, and administered by firmly pressing down the face-piece. Gibbs strongly recommends that chloride of ethyl be evaporated into the bag instead of being poured in. This may be accomplished by having an apparatus with a glass tube connected by 4 inches of red rubber tubing to a metal tube attached to the bag mount by a ball and socket joint. The required dose is poured into the glass through the rubber tubing, which is then slipped over the metal tube. The glass tube is immersed in a cup of very hot water, which is lifted up to it, and the rate of evolution of the gas can be regulated at will by approximating on removing the cup of water (see Fig. 2).

A mixture of *Nitrous Oxide gas and Oxygen* is probably the safest general anæsthetic agent at present known for surgical work. A special apparatus, however, and considerable experience with its use is necessary in order to obtain satisfactory results.

Local Anæsthesia.

(3) **Cocaine** hydrochloride, owing to its highly toxic character, is seldom used now except for application to mucous surfaces (5 to 10 per cent.). For hypodermic injection it has been supplanted by other preparations similar in action, but less dangerous. Of these Novocain is generally considered the best, although some surgeons prefer β-Eucain and others Alypin. For Spinal Anæsthesia, Tropacocain, recommended by Bier, is preferred in Germany; Stovaïne in France; not a few surgeons in different countries use novocain for this purpose also.

(*a*) A 5 per cent. solution of Cocaine hydrochloride is used for application to *mucous surfaces*, the method varying with the nature and accessibility of the part. Thus, we drop the solution into the conjunctiva when removing foreign bodies, etc. We may use it with a spray for the nostrils or apply it on a pledget of cotton wool. It may be rubbed on to the pharynx and tonsils. The insensibility thus produced favours the use of such instruments as the laryngoscope and tonsil guillotine.

Caution.—As deaths have occurred after injection of cocaine, especially into the urethra, this drug should not be used for that purpose. A 2 to 5 per cent. solution of Eucain or Novocain in normal saline with three or four drops of adrenalin per ounce, if injected into the anterior urethra, relieves congestion and spasm and facilitates the passage of catheters. Previous to the use of the cystoscope the same fluid, after being injected into the anterior urethra and retained there by grasping the glans penis, should be massaged backwards to the posterior urethra. No injection should be made if there is any reason to believe that the mucous membrane has been

lacerated, as the fluid may then pass directly into the venous circulation.

(*b*) *Infiltration Method of Schleich.*—A ·5 per cent. solution of Novocain in normal saline with three or four drops of Adrenalin solution per ounce is recommended by Braun and Bier. From 80 to 120 c.c. of this solution (℥ij. to ℥iiiss.) may be safely injected into an adult. (Many surgeons find a ·25 per cent. solution efficient, especially for the fascial structures.)

Eucain in ·2 per cent. solution in normal saline with similar quantity of adrenalin is recommended by some.

Caution.—The use of normal saline as a solvent is important, especially with Eucain. This drug dissolved in distilled water is apt to cause sloughing of the tissues. The anæsthetic solutions should be boiled shortly before use, and the adrenalin added afterwards. Alkalies destroy Cocaine and its allies, hence syringes or needles if boiled in soda should be washed out with normal saline before they are used.

Glass syringes must be inserted into the water while cold, and after boiling be allowed to cool gradually. If the piston be of metal, it must be removed before boiling and not reinserted till it and the syringe are cool. The more rapid expansion of the metal piston is likely to burst the glass barrel if the two are boiled in position.

A solution of hydrochloride of Urea and Quinine from ½ to 1 per cent. in distilled water has the special advantage of producing a local anæsthesia which lasts for several days. It causes a fibrinous exudation on a surface wound, which delays healing, and it is slower of producing the anæsthetic effect than Cocaine. Hence it is not much used for skin wounds. It is very valuable, however, for allaying the after-pains of wounds where fascial structures are sewn up, as in operations on the abdomen, or where masses of tissue are constricted, as in the treatment of internal piles. Crile employs this agent also to block off nerve impulses from the parietal peritoneum and mesenteric attachments.

Many surgeons find it sufficient to inject the subcutaneous tissue without injecting the more superficial layers of the skin. Others employ the endermic method as follows:—

The needle is introduced into the skin parallel with its surface and an endermic injection of about 5 minims made, which, of course, raises an œdema, and the skin blanches. From this area the needle may be carried inwards, and succeeding areas be infiltrated along the projected line of incision. The deeper structures may also be similarly treated, even down to the periosteum. We have to avoid veins. Where dissection is required, successive layers of fasciæ and muscle may be infiltrated after division of the skin. The injection should not be made directly into inflamed tissues.

Infiltration anæsthesia is of great value in minor surgery. Circumcision, the removal of digits, operations for fissure, piles, varix, tenotomy, lipomata, epithelioma of the lip, etc., can be conducted painlessly under its use. It lends itself also to many major pro-

cedures when the general anæsthetic is undesirable or refused, such as thyroidectomy, herniotomy, and excision of the tongue. In many laparotomies the method is pre-eminently successful, and the more so since the peritoneum is insensible to pain. It is advisable, however, after dividing the skin, to make a fresh injection into the extra-peritoneal tissue, since the outer aspect of the peritoneum is very sensitive. Gastrostomy, colostomy, gastro-enterostomy, cystotomy, and other grave operations may thus be performed with little inconvenience to the patient.

Regional Anæsthesia.—Injection into a nerve trunk causes anæsthesia of the peripheral area supplied, and can be used with great advantage, auxiliary to the infiltration method, in the course of a dissection, where visible nerve twigs are exposed. These may be at once rendered insensitive by injecting into them a few minims of 2 per cent. solution of Novocain with adrenalin in proportion of three or four drops per ounce. Moreover, this method may be employed alone, the solution being injected into main trunks at known points —*e.g.*, radial, ulnar, or digital nerves. It has been specially urged as a means of "blocking" the conductivity of large nerve trunks to avoid shock in major amputations.

Spinal Anæsthesia.—By the injection of suitable drugs into the theca vertebralis, we obtain an analgesia of the lower extremities, pelvis, and trunk, extending even to the axillæ. We owe this advance to Bier, of Berlin, whose present method is as follows:—The preliminaries resemble those of an ordinary diagnostic lumbar puncture, but the needle has a shorter bevelled cutting end. The patient occupies the ordinary sitting posture, his head forced down on his chest by an assistant, and the back arched so as to make the spinous processes project and increase the space between the neural arches, or, if this position be inadvisable, he lies on his right side, a pillow supporting the lumbar region, thorax, shoulders, and head, the knees and thighs flexed, and the back similarly curved. The skin is now carefully cleansed with ether and alcohol; soda, iodine, and the like agents are not used by Bier, but other surgeons do not find that they affect the contents of the syringe. The syringe and the needles have been sterilised by boiling in normal salt solution. The flaçon, in which the required dose of the drug is supplied, having been disinfected, is warmed in normal salt solution to the temperature of the blood, and the most stringent aseptic precautions are throughout rigidly observed. At a point in the mid line, corresponding to the highest level of the iliac crests, the special needle, carefully sterilised, is now carried inwards and made to penetrate the fourth lumbar interspace. As the needle passes deeply its trocar may be withdrawn, and the needle, directed onwards, perforates the theca vertebralis, and a free flow of cerebro-spinal fluid ensues. If no fluid appear, or should blood be withdrawn, the needle must be removed and reintroduced afresh or at a higher level. The syringe is now at once fitted on to the needle. It contains the contents of an ampoule of the tropacocaine solution previously drawn into it (dose ·05 to ·08 grm.). Ten c.c. of

cerebro-spinal fluid are withdrawn with the syringe very slowly, and then as slowly the whole is now injected. The needle is next smartly removed, and, should an abdominal anæsthesia be required, the patient is placed in the Trendelenberg position with the head flexed, till the cutaneous anæsthesia reaches to about the ensiform cartilage. The patient is then gently returned to the horizontal. The anæsthesia obtains for over an hour. The absence of reflexes, knee-jerk, abdominal and epigastric, together with the lack of painful sensation, shows the level to which the action extends. The perineum is first rendered insensitive, then the feet, and so the action passes upwards. For specially high-reaching anæsthesia, the needle may be introduced between the first and second lumbar vertebræ, or even between the last dorsal and first lumbar.

After operation the patient should be gently removed to bed, with the head and shoulders kept raised. The syringe and needles have now to be scrupulously cleansed with warm water, boiled in sterile water, washed out with alcohol and ether, and dried.

The method has proved of great value, more especially in the case of old people, also for extirpation of the rectum, prostatectomy, Wheelhouse's operation and disarticulation at the hip joint, etc. Patients are wonderfully well after its use, and in cases of accident with shock, where amputation of the lower extremities is necessary, it gives excellent results.

On the whole, Tropacocaine seems the safest drug for spinal anæsthesia. Other drugs have been employed, such as Novococaine, etc. Barker uses stovain and glucose. Spinal anæsthesia requires great caution, and prolonged experience is yet required to fairly establish its future position and possibilities.

(4) *Local Insensibility by Cold.*—Local anæsthesia may also be produced by rendering the part *bloodless* after Esmarch's method, and by freezing. For this purpose the Ether spray, Ethyl chloride, or Anæsthetile may be used. The two latter are supplied in convenient small cylinders. On opening and inverting, the fluid is sprayed over the field of operation or over the nerve trunk which leads to it. The skin speedily becomes dead white and insensible. The thawing is painful, but pain may be mitigated by applying cold lotions so as to thaw slowly. The method is more specially useful where infiltration fails, as in acute inflammations, whitlows, etc.

In nervous subjects, local anæsthesia may be supplemented by previous injection of morphine, or omnopon with the addition of scopolamine if thought advisable.

CHAPTER IV.

ANTISEPTICS AND WOUND TREATMENT.

Contents.—Antiseptic Treatment and the Germ Theory—**A. General Antiseptic Principles and Practice**—Antiseptic Materials—Cautions necessary in the use of Antiseptics—Various Antiseptics and their Relative Advantages: Carbolic Acid, Corrosive Sublimate, Iodoform, Boracic Acid, Chloride of Zinc, etc., etc.—Use of Antiseptics during Operation, Cleansing of the Hands, Gloves—Antiseptic Ligatures, Dressings—Closure of the Wound, Drainage, etc.—Aseptic Surgery—Treatment of Sepsis—Strapping.

A. General Antiseptic Principles and Practice.

THE whole question of the treatment of wounds turns upon the differences which obtain between a compound and a simple fracture, an injury with skin broken and one in which it remains intact. All surgeons endeavour to bring wounds into a condition comparable with that in which the skin is unbroken. Speaking generally, we may say that inflammation does not attend subcutaneous injuries. Wherever the epidermis is removed, however, external noxious agents may be brought into contact with the injured tissues, and inflammation and fever ensue. This is entirely due to the elaboration of toxins from the growth and development in the wound secretions of micro-organisms, which, abounding more or less in the atmosphere are deposited everywhere. These germs vary in number, virulence, and vitality—many of them, more especially those associated with putrefactive changes, thrive in dead or dying tissue, aided by moisture and heat, conditions which they find in wounds. It is against such organisms coming directly from without that the surgeon battles.

A second series of microbes, not only attack wounds from without, but gain entrance to the system through the alimentary, respiratory, and other tracts. Many of these give rise to special diseases, such as tubercle, and the like. Sometimes they retain their vitality in the tissues and the blood-stream for a considerable time, and only give direct evidence of their presence by congregating and multiplying at spots where there has been some local injury sustained, or where some local weakness exists. It is in this way that we explain the micro-organismal formation of acute abscess.

Since inflammation and blood-poisoning, ensuing on the receipt of a wound, is thus caused, it follows that all successful wound-treatment is based upon a recognition of the **germ-theory**, and should be conducted entirely on the **antiseptic** principles of Lister. This implies that our object is not so much to treat the wound itself, as its surroundings. We exclude microbes from our wounds by effecting their destruction externally, or, if they have gained a footing, we destroy them within the wound by the use of local antiseptics, and by

strengthening and aiding the tissue, we render it an unfitting soil for germs.

Antiseptic Methods and Materials.—While the principles of antiseptic or aseptic treatment laid down by Lister remain established, the methods and materials employed vary greatly in the hands of different surgeons. It is obvious that the utmost care is required in thorough disinfection of everything that comes in contact with the wound, and that constant vigilance must be exercised lest *reinfection* from touching septic surfaces occur. Thus the end of a ligature may touch the coat of an assistant just before use, and so lead to an implantation sepsis; or the surgeon may inadvertently brush back his hair, and so with unclean hand plant mischief in the wound. Such errors easily arise, hence it is advisable to rinse the hands repeatedly during an operation in some active antiseptic lotion. Custom speedily makes the observance of antiseptic detail a reflex action, but when a wound goes wrong, the surgeon generally finds that he or his assistants have been at fault. The question of *atmospheric contamination* arises. This is liable to happen in badly constructed and foul operating theatres, more especially if they are also utilised as demonstration and lecture rooms, but for all practical purposes may be ignored. It was to obviate aërial contamination that the carbolic spray was introduced. This appliance was in turn replaced by gentle irrigation with the less irritating antiseptics, and later surgeons, rejoicing in the pure atmosphere of well-regulated operation rooms, have dispensed with such precautions. Sterilisation by steam and boiling largely replaces the use of active antiseptic substances, but can never effectually replace them for the purification of the skin, etc., and antiseptics are also constantly required for the preparation of dressing materials.

Cautions necessary in the use of Antiseptics.—Before proceeding to describe the various antiseptics in use and their application, one word of caution.

The more potent the antiseptic, the more likely is it to react injuriously on the tissues; and, moreover, poisonous effects often follow when Carbolic acid, Mercurial salts or Iodoform become absorbed.

Some patients are peculiarly liable to disastrous results, even from small doses, and where such idiosyncrasies are displayed, the offending drug must be at once removed, its effects antagonised, and a milder and less irritating antiseptic substituted for it. Care should be taken to use only pure preparations of the various antiseptics.

Various Antiseptics: (a) Carbolic Acid (Phenol).—By far the most useful antiseptic, and certainly that of most general application, is carbolic acid. It is volatile, searching, penetrates hair and epithelium, combines readily with oils and alkalies, and does not damage instruments like the preparations of mercury. It is used in the form of lotion by dissolving pure phenol in water. The strong solution (1 to 20) is used for purifying the skin, sponges, towels, and instruments. The weaker solution (1 to 40) is employed in

connection with parts and instruments *already purified,* and for irrigation. Carbolic acid in oil or glycerine is used for catheters and dressings.

Caution!—Carbolic acid poisoning exists in varying degrees. The passage of urine which is olive green, and which darkens gradually on standing, is the first indication of carbolic acid absorption, and is in itself of little moment. Headache, giddiness, and sickness are of greater import, more especially when these are associated with the absence of sulphates from the urine. In extreme cases, low temperature, extreme depression, and collapse ensue. Treatment consists in a change of antiseptic, together with the administration of sulphate of magnesium, which, it is hoped, will combine with the free carbolic acid in the system, and be excreted as harmless phenol-compounds by the kidneys. In addition, stimulation may be required.

(b) Corrosive Sublimate is at present one of the most universally employed antiseptics, being cheap and effective. It is non-volatile. It corrodes metals, and, hence, can only be used in glass, porcelain, or vulcanite. In solution, 1 to 500, it has been used for the hands and skin, but in this strength it is rather irritating. 1 to 1,000 is the stronger form of solution used for general purification, while 1 to 2,000-5,000 is that employed for irrigation. When used to purify septic wounds, it should be employed in large quantity, as the mercury is speedily used up by forming compounds with albumen, and the lotion is thus apt to become inert. For the same reason it is inferior to carbolic acid for purifying the skin. The addition of common salt to the solution prevents this action.

Wood-wool wadding, absorbent wool, gauze, jute, and wood-wool are all to be had charged with Corrosive Sublimate, and make excellent dressing-materials.

Caution!—Corrosive Sublimate solutions must be used with the greatest care. It is probable that more deaths have occurred from the use of mercurial salts as antiseptics, than from that of carbolic acid. Irrigation of absorbing surfaces—as, for example, the tunica vaginalis and pleura—is fraught with danger. Diarrhœa, vomiting, collapse, and death may rapidly ensue. Absorption is also prone to occur if an extensive corrosive wool dressing becomes saturated with discharge and evaporation be prevented. A moist corrosive application also causes irritation and pustulation of the skin; hence a corrosive wool poultice is a dangerous agent for purification.

In order to obviate the danger so often produced by corrosive sublimate, other compounds as effective and perhaps less irritating have been advocated. Amongst these we may mention sal alembroth, and biniodide of mercury.

(c) Iodoform has obtained a great reputation from its marked deodorising properties, and from its supposed special action upon the tubercle bacillus. The fine sublimed crystals, mitigated with boracic acid or bismuth, should be lightly dusted over the wound. It is an antiseptic in virtue of the amount of iodine which it contains. It is soluble in fats, oils, ethers, etc., but not in water or in serum.

Ptomaines also liberate the iodine. It slowly purifies a septic wound, favours the growth of healthy granulations, lessens the irritability of sensory nerves, and prevents the growth of tubercle bacilli. It unfortunately possesses a vile, penetrating odour, which is with difficulty disguised. It may produce erythema of the skin. Iodoform gauze forms a most admirable tampon in abdominal and pelvic surgery.

Caution!—Iodoform should always be used with great discretion. There is no occasion to apply it in large quantity to wounds and absorbing surfaces. Children, as well as old, fat, and weak people, are especially liable to be affected injuriously. Fatal results have followed its accumulation in the deep recesses of wounds after insufflation. The symptoms vary from sudden collapse, associated with brain-symptoms and vomiting, to milder forms of loss of appetite, mental depression, and excitement. When the patient complains of feeling its taste and smell in everything, its use must be discontinued, and the patient stimulated and treated to plenty of fresh air. The presence of iodine in urine is readily detected by shaking up a little starch in the urine, adding a few drops of fuming nitric acid, and the blue reaction is declared.

(d) **Boric, or Boracic Acid,** is one of the mildest and most unirritating germicides we possess. It may be used in saturated watery solution (1 to 30), or dusted on copiously when finely powdered. It is specially applicable in open wounds after their preliminary purification with stronger agents, and highly suitable for irrigating the bladder. It is practically non-poisonous.

(e) **Chloride of Zinc,** in the strength of 40 grains to the ounce of water, is a most potent, safe, and lasting disinfectant. It is a valuable medium with which to soak strips of lint for use as plugs after operations in the vicinity of the oro-nasal cavities. It will maintain its action for forty-eight hours. It is, however, somewhat painful, and latterly it has been replaced by iodoform, or iodoform mitigated with boracic acid or bismuth.

(f) **Peroxide of Hydrogen** owes its antiseptic property to its breaking up and setting free oxygen gas when it meets with discharge. There is no better agent for loosening crusts or gauze packing, or for penetrating the recesses of a wound or joint cavity.

(g) **Other Antiseptics.**—Amongst the many other powerful antiseptics, all of which have had their advocates, we may mention *salicylic acid, thymol, acetate of alumina, lysol, subnitrate of bismuth, iodol, and aristol.*

Mode of using Antiseptics during Operations.—Previous to operation, the skin of the whole part should be carefully prepared (see p. 7). The patient should be warmly covered with blankets. By spreading one or two sheets of mackintosh, covered with carbolised towels, over the clothing, in the vicinity of the field of operation, an antiseptic area is provided, whereon instruments, etc., may be laid with safety. A mackintosh beneath the patient serves to protect the blanket. Everything being in readiness, while the

patient is getting "under," the surgeon proceeds to disinfect his hands.

For this purpose we cannot employ the absolute methods used for the sterilisation of instruments. To obviate sepsis-implantation by the surgeon and his assistants is still the crux of aseptic surgery. No method can be regarded as perfect. Most surgeons use sterilised rubber gloves, but a few rely on vigorous mechanical cleansing followed by the use of antiseptics, and, in addition, rinse the hands frequently during the course of an operation in a sterile or mild antiseptic lotion. Mickulicz strongly recommended as most efficient, time-saving, and economical, the spirit soap of the German Pharmacopœia. It is sufficient to apply this with sterilised nail brush or gauze for the space of five minutes.

One of the most efficient methods is Ahlfeld's hot-water-alcohol method, slightly modified by Schæffer—*e.g.*,

(1) Scrub the hands thoroughly *in* (not over) a strong solution of green soap in water as hot as can be borne. This must last for at least ten minutes, and during the time the water must be changed two or three times. Use a sterilised nail brush. Between the changes of water the hands should be well rubbed with sterilised fine sand made from powdered marble or pumice stone. Before the last change, scrape under and round the nails with some convenient blunt instrument.

(2) With another sterilised nail brush, scrub for five minutes in methylated spirits once changed.

(3) Bathe the hands in 1-2000 corrosive sublimate solution.

Cheyne recommends to sponge the hands with turpentine, to wash thoroughly with soap and Lister's "strong mixture" (5 per cent. carbolic lotion, containing one five-hundredth part of corrosive sublimate in solution) and a nail brush, then to clean the nails carefully with a knife. The hands, which are now dried, are repeatedly dipped thereafter in 1-2000 corrosive lotion, before and during the operation.

It is always advisable to protect the hands as far as possible from contact with septic material. Soiled dressings should be removed with forceps, rubber gloves should be used for septic operations, rectal examinations, etc.

Rubber gloves are now worn by most surgeons during an operation. They may be sterilised either by boiling in plain water for ten minutes, or by being placed along with the dressings in a steam steriliser. If the steam is under pressure the higher temperature deteriorates the rubber more rapidly than boiling in water. Before being placed in the steam chamber the gloves should be dusted inside and outside with French chalk, lightly packed with gauze, and loosely wrapped in the same.

Gloves sterilised dry with French chalk slip on easily. Wet gloves cling to the hands, but they can be put on either after the hand, or the inside of the glove, has been moistened with glycerine and boroglyceride, or after the glove has been filled with boiled water

or a weak antiseptic lotion. Strong alkalies or oily substances attack the rubber.

The use of rubber gloves does not relieve the surgeon from the need for thorough cleansing of his hands. A perforation of the rubber might occur at any moment during the operation, and organisms mingled with perspiration would then be discharged into the wound.

Rubber gloves can be cleansed more easily than the skin of the hands with its sweat glands and fissures, hence by the use of soap and water, spirit, and antiseptics, the same gloves may be used in successive aseptic operations. After a septic case, a freshly sterilised pair should be used.

Antiseptic Ligatures and Dressings.—Catgut ligatures, prepared according to the various formulæ in the *Appendix*, are to be used. A difficulty arises in getting good catgut, and it is better that the surgeon should either prepare his own or deal only with reliable makers. Wound infection has often been traced to faulty catgut. Under these circumstances, some have preferred to use silk, duly purified (see *Appendix*). As shown by Lister, this, when aseptic, is gradually absorbed by the tissues. The process is, however, much slower than with catgut. Should sepsis take place the silk ligatures invariably slough out. The finer the silk, and the smaller the amount left in the wound, the less risk there will be of this. Strips of fresh ox aorta, kangaroo tendon, and allied animal textures have been prepared like catgut.

Closure of wounds is effected by sutures of linen thread, silk, silk-worm gut, horse-hair, or silver wire, which will require removal, or by catgut, which becomes absorbed. Michel's metal clips are exclusively used by some surgeons. The results obtained, however, are in no way better with them than with carefully prepared sutures, while the patients find the clips more painful in removal. The margins of the wound should be closely and accurately applied, each epithelial edge meeting its fellow, and no fat protruding. In wounds which unite by the first intention, and which are aseptic, the "Continuous" suture may be used. It is finished off by slipping the double end of the suture under the last stitch, and tying over that (Fig. 3). Tension is met by the use of Lister's button suture, which gives excellent results. It permits the relaxed edges of the wound to lie in apposition. Similarly we may employ deep buried stitches of catgut. When the edges will not meet we may cover the raw surface with Thiersch grafts (see p. 46).

Drainage is effected by means of ordinary rubber tubing, thin rubber sheet ("dam") rolled up with or without a core of gauze, glass tubes, or by media which become absorbed, such as prepared catgut. There is a great advantage in making separate apertures for the drains at the most dependent part, encouraging union by the first intention along the line of incision. A dependent aperture is made by thrusting a closed forceps from the wound through the tissues, till the skin is tense over it, and then incising. In this way

danger of injuring blood-vessels or other important structures is reduced to a minimum.

In many cases, no drain is required. In the case of the abdomen, the peritoneum carries off secretion. When wounds are aseptic, the cut surface not too extensive, and where careful dressing has obliterated every cavity, no artificial drain is required. It sometimes happens, however, that a little discharge does take place, and this by evaporation may cake on the dressing, dam up some further residue, and thus create tension. Hence, a drainage tube should be used in all doubtful cases, for at least twenty-four hours.

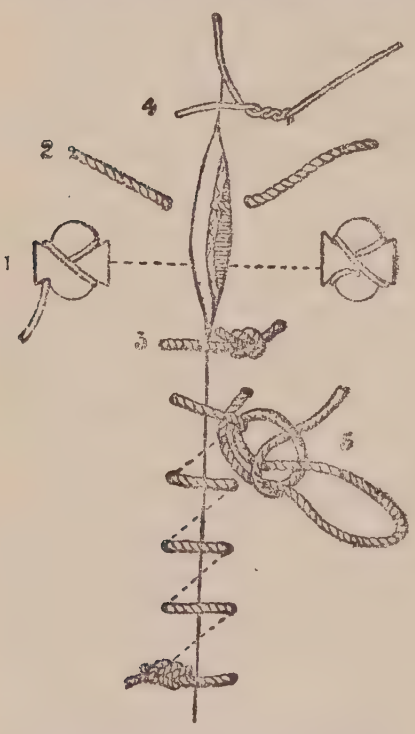


Fig. 3.—Method of Closing Wound—1, Lister's wire button suture; 2 and 3, interrupted suture; 4, suture of horse hair, showing double twist; 5, continuous suture.

After operations for septic peritonitis from any cause a drain may be necessary in the pouch of Douglas or elsewhere. A large rubber tube acts well with or without a wick of gauze. If a glass tube is used it must be rotated on its own axis at least once a day. Otherwise omentum is apt to be forced into the side holes and to become fixed there.

Mickulicz bag is often useful in packing some definite part of the abdominal cavity—a large piece of sterile gauze is spread out over the area to be packed and the packing proper is pushed into this piece. The packing is thus held together at the proper place, and it can also be more easily withdrawn than if it were free.

The Dressing.—An efficient covering for the lips of the wound is found in three or four folds of sterile gauze, dry or moistened in a weak antiseptic lotion. Dressing in copious amount is now applied, arranged so as to bring together raw surfaces, and to obliterate all cavities. It should extend well beyond the confines of the wound. Finally, a firm bandage, splints, and other supports, as need be.

When to change the Dressing.—Should discharge appear at one spot, the surface there may be moistened with an antiseptic lotion and a fresh pad put over it. If the discharge be in quantity, a new dressing is required. With absorbable drains and stitches, all may be left untouched for an indefinite length of time should a favourable

course be pursued. When tubes and sutures have to be removed, the tubes may be taken out in twenty-four hours, the deep stitches on the third and fifth, and superficial on the seventh or tenth days, or about the third day if stitch marks are to be avoided. An area of redness round any stitch calls for its removal. A slight rise of temperature generally takes place on the second or third evening in any case, but there is no occasion to dress unless something has gone wrong with the wound, as is evidenced by the temperature being above 100° F., by quickening of the pulse, or by local pain or disturbance, without other known cause.

Aseptic Surgery.—Surgeons reach the ideal of thoroughly aseptic wound treatment by operating in an aseptic room, with aseptic surroundings, dressings, and instruments. In practice this presents but little difficulty, in war it must often be well nigh impossible. The method employed by Neuber in his private hospital, at Kiel, is remarkable for simplicity and success.

The table, mackintoshes, vessels, etc., are all washed with soap and water, and then with 5 per cent. carbolic lotion.

The patient has already been well bathed, and the site of operation purified with carbolic lotion. The instruments, which, after the last operation, had been washed, boiled, and put away, are now rolled in a napkin and boiled over a Bunsen burner for twenty minutes in order to sterilise them, and thence transferred to ½ per cent. carbolic lotion. The surgeon's hands, those of the assistants and nurses, and the skin of the patient are purified as usual.

A copious supply of sterile salt solution is ready. It is practically the normal saline solution (p. 79) sterilised by boiling.

Gauze is sterilised by boiling for half an hour, and is then used freshly prepared, or, like the sponges, it may be stored in 5 per cent. carbolic lotion, and wrung out of the sterile lotion before use.

The operator's hands, and everything that comes in contact with the wound, are purified with 5 per cent. carbolic and are then rinsed with the sterile fluid to get rid of the antiseptic, and leave them aseptic. The bleeding points are carefully secured with catgut, and the wound flushed with the sterile fluid, poured from a jug. The wound is now dried with the moist gauze, and a pad of the gauze is laid over the raw surface, and the wound is closed by a continuous suture. Before the last stitches are tightened, the gauze compress is gently withdrawn, and the dressing applied. External drainage is not generally required. The tissues have sustained the minimum irritation, and are able to cope with the ensuing effusion. Union by the first intention is the rule.

It will be observed that sterilising by moist heat is the great antiseptic, and that active antiseptics are retained for objects that cannot be so purified. Iodoform is used in tuberculous cases. Separate operating chambers are set apart for aseptic, septic, tuberculous, and other cases.

Modern aseptic surgery generally follows the method of Schimmelbusch, which demands the most rigorous, and even reflex, thorough-

ness of every detail. The operating rooms are constructed with a view to prevent the harbouring of dust. The walls, floors, and roofs are smooth, their angles rounded off, and they are daily flushed with hot water or antiseptics. Tables, shelves, and furniture are constructed of glass or metal. Moist heat takes the place of chemical antiseptics for disinfecting, and by boiling the instruments and sterilising the dressings, etc., with steam, asepsis is secured. The gauze dressings, swabs, towels, aprons, etc., are lightly packed in *perforated* metal boxes, which are placed within a steriliser (see *Appendix*). Here they are subjected for an hour to the action of a current of steam at a temperature of 100° C., or a less time in steam under pressure. The boxes are then removed, the perforations which admitted the steam closed, and the now sterile contents are ready for use. Of necessity, we cannot boil the patient or the operator's hands, hence the integument must be purified with antiseptics (p. 7) and then rinsed with sterile salt solution, of which quantities are kept on tap. Sterilised rubber gloves are of the highest value. A gauze mask or veil covering the nose and mouth is a further aid in protecting the field of operation. Sterilised cloths take the place of the more old-fashioned moist antiseptic towels, and the staff array themselves in sterilised aprons, gloves, etc. The instruments, having been boiled for twenty minutes (*Appendix*), are placed in salt solution or in weak carbolic. Dry sterile swabs are used for sponging and for covering the wound. Over all a mass of sterile cotton wool, sphagnum, or other suitable material is bound to absorb discharge and act as the main dressing. Only a minimum of any antiseptic need touch the wound, namely, that contained in the ligatures and the little upon the instruments. Recent advance, especially in the surgery of the abdomen, has been made chiefly under the aseptic method. It is open to question, however, whether the results in *general* practice are better than those obtained by the present antiseptic method.

Sepsis after Operation.—Should this occur, according to the severity of its effects and the local condition of the wound, it will be necessary to remove stitches where there is the least degree of tension to open up freely, and promote drainage in every way. The dressing should be wrung out of an antiseptic lotion and be kept moist with waterproof tissue. It should be changed once a day or oftener. We have to content ourselves with favouring granulation, so that there shall no longer be an absorbing surface. Meanwhile, by the use of cardiac tonics, stimulants, and nourishment, we promote the patient's strength till the poison is thrown off. Special sera, depending upon the species of the organisms present, may be of avail (see *Appendix*).

Septic Wounds.—In the case of recent compound fractures and joint-wounds, where the recesses have been manifestly exposed to septic influences, most thorough and prolonged irrigation must be used. The skin should also be shaved and purified. If the margins of the skin wound are very dirty they may be clipped off with scissors. Where dirt and sand have been ground into cartilage and bone, the bone-pliers and knife may be used to remove the engrained tissues.

Do not otherwise remove bone, even although loose. If sepsis be conquered, the weak part will live. Free incisions may be made to avoid tension, and drainage-tubes inserted. Where a sharp end of bone projects, which has been exposed and cannot readily be replaced, it is well to remove it.

Wounds which are septic are generally accompanied by pain, fever, inflammation, and unpleasant odour (see p. 41).

Fig. 4.—Closure of Wound with laced adhesive plaster and collodion strapping.

Strapping. — Strapping is sometimes employed in lieu of stitching, or is put on when the wound shows a tendency to gape after the removal of sutures. Much neater and more serviceable, however, is the use of collodion with unprepared gauze. A strip of gauze should be laid over the wound, and one end of it secured to the skin by painting on the collodion with a brush. When this dries, traction may be exercised, and the skin pulled towards its opposing flap, which is pushed forwards with the fingers, and the other extremity secured in like manner to the skin. The whole extent of the incision may also be fortified by painting with collodion. Kocher combines bismuth with it, and this forms an efficient species of non-irritating plaster. A doubled fold of gauze may thus be affixed to each side of the wound, and, when secured, the two may be brought together by lacing, as in Fig. 4. Flexile celloidin may with advantage replace flexile collodion.

CHAPTER V.

ANTISEPTICS AND WOUND TREATMENT—(*Continued*).

Contents.—B. Special Wound Treatment.—Gun-shot, Lacerated, and Punctured Wounds—Divided Tendons—Nerve Injuries—Burns and Scalds—Ulcers—*Skin Grafting*—Sinuses—Erysipelas—Whitlow—Passive Congestion in Acute Inflammation—Blisters.

B. Special Wound Treatment.

(1) **Gun-shot Wounds.**—Gun-shot wounds in civil practice are generally caused by accidents with fowling-pieces charged with small-shot, or they result from homicidal or suicidal wounds from pistol or revolver.

It need, perhaps, hardly be insisted on, that asepticity of such wounds, as of others, is one of the most important elements in their treatment. When none of the body-cavities have been penetrated, the first indication will be arrest of hæmorrhage, temporarily with a tourniquet, then permanently. Under antiseptic precautions, portions of clothing, wads of paper, or other foreign soft matter that may have been carried into the wound should be at once removed, likewise splinters of wood and greatly comminuted fragments of bone; the finger, properly cleansed, should be used as an exploring probe. If small shot in great numbers, or a bullet, have lodged, they should be searched for and removed, and the wound should be washed out with antiseptics. Isolated pellets may be safely left alone.

The surrounding parts should be thoroughly cleansed and purified, an antiseptic dressing applied, and the whole fixed in a splint.

Penetrating wounds *of the abdomen* are dealt with elsewhere (see Chap. ix.). When these wounds occur *in the thorax*, little can be done except to stop superficial bleeding, remove superficial foreign bodies, apply antiseptic dressing, and keep the patient perfectly quiet, resting chiefly on the injured side. *In the skull*—besides the general principles already laid down, the indications for treatment are mainly those of depressed fractures of the skull (see Chap. ix.).

Some general rules, framed for the examination of gun-shot wounds in military practice, may be mentioned here.

(*a*) Ascertain, if possible, the exact position of the patient at the moment of injury, and the direction from which the injury came. This will greatly help diagnosis of the probable injury and the track of the shot.

(*b*) Examine the clothes, to see if any parts are wanting, and hence, possibly carried into the wound.

(*c*) See if there is any wound of exit.

(*d*) Search for bullets by passing the hand lightly over possible seats.

Should symptoms of septic inflammation appear in the track of the bullet, free incisions must be made to permit of irrigation and drainage.

(2) **Lacerated Wounds** owe their dangers to the damage done to the tissues, and to the frequency with which septic matter is rubbed into them. Even with the greatest care and trouble, it is generally impossible to purify them in the ordinary way. Consequently, the immediate dangers and subsequent troubles of sepsis are specially great.

When a lacerated wound is first seen, the surrounding skin should be cleansed and purified, and the wound itself freed from all apparent dirt. Portions of lacerated muscle ingrained with dirt should be snipped off and the skin, if necessary, scraped with a Volkman's spoon. Afterwards, the wound should be scrubbed with 1-20 carbolic, tincture of iodine (B.P.), or other reliable antiseptic. It may then, after bleeding points have been secured, and torn nerves and tendons brought together with catgut stitches, be protected by an antiseptic dressing. In the hand and arm, however, all doubtful cases should be immersed in a bath of warm antiseptic lotion. Corrosive sublimate

lotion 1-4000 answers well, and cases kept in it for several days show no sign of poisoning. When a virulent type of sepsis exists, a 10 per cent. solution of ichthyol in water should be used. The fluid is expensive, but it can be reheated. Carbolic acid about 1-80 or 100, salicylic acid 1-300, or boracic acid, saturated, may also be used, but carbolic is too easily absorbed,* and boracic acid is not strong enough for bad cases. The fluid should be renewed daily, and every three or four hours part of it may be replaced by hot lotion, as the bath cools. The patient's head and shoulders should be propped up in bed. The

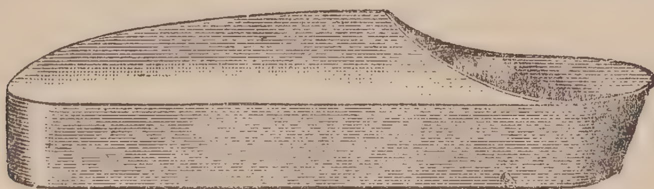


Fig 5.—Arm Bath.

bath (Fig. 5) may either rest upon the bed, or be supported alongside the bed, on a slightly lower level than the mattress.

On the third or fourth day, or even sooner, the limb may be safely withdrawn from the bath, and treated with ordinary antiseptic dressings. If the patient is unable to sleep owing to the constrained position entailed by the bath, after the first twenty-four hours it may be used only by day, while at night the limb is wrapped in cloths soaked in the lotion. The bath is, however, more efficient than the soaked cloths, and in bad cases should be kept up if possible. The

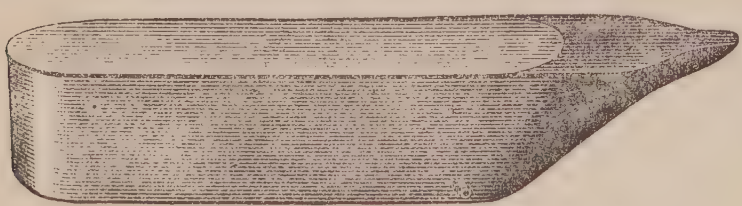


Fig. 6.—Foot Bath.

best form of bath is that shown in the figure. It is made of enamelled iron, and can be had of any large ironmonger.

If septic inflammation should supervene, passive congestion (p. 49) is indicated. It has now largely taken the place of the bath, as well as of irrigation and antiseptic poultices, but it may be combined with these measures.

The difficulties involved in immersing the foot or leg in a bath (Fig. 6) are greater than those met with in immersing the upper limb. The leg should be flexed at the thigh, with the knee raised,

* The warning of extensive absorption of carbolic acid will be given by a greenish discoloration of the urine.

or the bath may be supported beside the bed, and the foot allowed to hang over the side of the bed into it.

Bad cases of burn to the trunk are treated by continuous immersion of the whole body, in hospitals in which the necessary accommodation is provided. The patient lies in a bath through which there is a constant flow of warm water.

Antiseptic "poultices" or irrigation with antiseptic lotions may be employed where the bath is not available. In irrigating, a cloth is laid over the wound, and from a bottle suspended over the part a constant drip takes place by means of worsted threads which act as syphons. A mackintosh cloth must be arranged to carry off the superfluous fluid. Antiseptic "poultices" consist of cloths soaked in such antiseptic fluids as are used for baths or irrigation. Evaporation is prevented by having the cloths surrounded with waterproof. It will be noticed that the chief difference between antiseptic poultices and irrigation is that in the latter the part is chilled by the free evaporation which is permitted. If there is much inflammation this is an advantage, but if there is any tendency to gangrene the cold will hasten it.

(3) **Punctured Wounds** (*i.e.*, those in which the depth of the wound is out of proportion to its other dimensions), owe their danger to risk of hæmorrhage, in the first place, and to sepsis and confinement of discharge, in the second. Should there be reason, from the appearance and condition of the patient, from the state of the parts, and from probable direction of the wound, to fear hæmorrhage, the surgeon should try temporarily to control the circulation in the part, and after enlarging the wound to find and secure the injured vessel. In an inaccessible region, such as the chest, rest, quiet, cold, and internal styptics are alone available. When rise of temperature, pain, and other signs of inflammation render the advent of sepsis probable, free incisions and drainage are indicated, along with passive congestion (see p. 49), where that method can be employed.

In ordinary cases, punctured wounds may be treated like compound fractures—*i.e.*, with the view of rendering and keeping them aseptic.

(4) When tendons are divided they are drawn up by tonic muscular contraction, so that the ends become widely separated. They should, however, be united by chromicised catgut sutures or fine silk. When there is any difficulty in finding the drawn-up ends, they will be readily brought into view by bandaging from above downwards, while the limb is at the same time placed in the position which relaxes the tendons most.

(5) **Nerve Injuries.**—When a nerve is completely divided, the muscles supplied beyond the point of section remain powerless until union takes place. The expected sensory disturbance may be complete, or it may be only partial, or even non-existent, because of abnormal distribution or anastomosis. As the result of the loss of the nerve stimulus, the muscles supplied by the divided nerve begin to degenerate rapidly and shrink. In recent wounds, the severed nerve-ends should, therefore, be carefully sought for and sutured together

with fine chromicised catgut or very fine silk. With a fine needle two sutures should be passed at right angles to one another, each transfixing the nerve and sheath about $\frac{1}{8}$ of an inch from the cut surface of each portion of the nerve. A few extra stitches may be used to draw gaping parts of the sheath together, but the fewer the stitches in the nerve itself the better (*Bowlby*). Subsequent restoration of function ensues. In old-standing cases, the longer the secondary suture is delayed, the less likely is it to be completely successful—the first sign of repair is return of motor power.

Pressure paralysis, as, for instance, the wrist-drop, due to interference with the musculo-spiral nerve in the axilla from the use of a crutch, yields to massage, electricity, and superficial stimulation.

(6) **Burns and Scalds** may be considered together as being both injuries caused by heat. They generally consist of more or less extensive injuries of the skin. The depth of tissue affected is not at first apparent, as frequently much is injured beyond what is actually destroyed.

The points to be attended to in their treatment are (1) rendering and keeping them aseptic, and (2) preserving them from every form of mechanical or chemical irritation.

Since from burns large raw surfaces frequently result, which at first are highly absorptive, the antiseptics employed must be not only unirritating but non-poisonous if absorbed. Hence carbolic acid and strong corrosive sublimate lotions are to be avoided. We may use, however, biniodide of mercury (1-4000), corrosive sublimate (1-2000), salicylic acid (1-300), or sulphurous acid (1-8 B.P.) lotions, boracic acid *ad lib.*, or eucalyptus oil, 10 per cent. After granulations have formed, the risks of absorption are much less.

Since heat is itself a powerful antiseptic agent, the affected surfaces will be at first aseptic. The surrounding skin must, however, be thoroughly cleansed and purified, and, as a precaution, the burned surface should be sponged over as well. In all cases where the asepticity is doubtful, an anæsthetic should be given, and the part well scrubbed with an antiseptic. Blisters should be cut and the fluid allowed to escape. Small burns should then be covered with wool and flexible collodion, while larger burns may be freely dusted with powdered boracic acid, and wrapped in absorbent antiseptic cotton-wool. Should asepticity have been ensured, no further dressing should be required. An aseptic burn heals with much less destruction of tissue, with much less local or general irritation and less after-scarring than a septic burn, and with none of its septic fever.

When burned or scalded surfaces are septic, the surgeon's first object will be to get rid of all dead epidermis and skin. What is already loose must be peeled off or clipped away, and charcoal poultices (see *Appendix*), and moist antiseptic dressings must be used to hasten the separation of the rest. Irrigation with antiseptic lotions must be frequent, and in some cases the use of a local bath of warm antiseptic lotion may be employed.

When granulations have well developed, their surface should be

covered with protective or with a moist antiseptic dressing. The contractions which result from extensive destruction of skin must be obviated by stretching the cicatrices when young. A little may be done by resisting contraction during healing, but generally such efforts only stop the healing process. Skin and epithelium-grafting should of course be practised in large sores.

Some surgeons are greatly in favour of oily dressings for burns. "Carron" oil—*i.e.*, equal parts of linseed oil and lime water—should never be used, as it has no antiseptic property. Antiseptic ointments such as boracic, may be used, or lint soaked in a modified carron oil—*i.e.*, equal parts of lime water and 10 per cent. of eucalyptus in olive oil. The value of the "carron" oil is probably that the lime favours the formation of an emulsion between the oil and the water, and that the evaporation of the water keeps the part cool. The escape of the water, however, tends to make the cloths stick when they are removed from the sore. The eucalyptus in olive oil does very well without the lime water.

Picric acid has been extensively used for the treatment of burns, and its value seems to consist in a combination of antiseptic, astringent, and anæsthetic properties. Mr. D'Arcy Power gives the following notes on its use:*—

"The solution of picric acid is made by dissolving a drachm and a-half of picric acid in 3 ozs. of alcohol, which is then diluted with two pints of distilled water, or more accurately: Picric acid, 5 g.; alcohol, 80 g.; dissolve; add 1,000 g. of distilled water. This is a saturated solution of picric acid.

"The clothing over the injured part should be gently removed, and the burnt or scalded portion should be cleaned as thoroughly as possible with a piece of absorbent cotton-wool soaked in the lotion. Blisters should be pricked, and the serum should be allowed to escape, care being taken not to destroy the epithelial surfaces. Strips of sterilised gauze are then soaked in the solution of picric acid, and are so applied as to cover the whole of the injured surface. A thin layer of absorbent cotton-wool is put over the gauze, and the dressing is kept in place by a light linen bandage. The moist dressing soon dries, and it may be left in place for three or four days. It must then be changed, the gauze being thoroughly well moistened with the picric acid solution, for it adheres very closely to the skin. The second dressing is applied in exactly the same manner as the first, and it may be left on for a week.

"The great advantages of this method of treatment are: First, that the picric acid seems to deaden the sense of pain; and, secondly, that it limits the tendency to suppuration, for it coagulates the albuminous exudations, and healing takes place under a scab consisting of epithelial cells hardened by picric acid. A smooth and supple cicatrix remains, which is as much superior to the ordinary scar from a burn as our present surgical scar is superior to that obtained by our predecessors, who allowed their wounds to granulate." He has been thoroughly satisfied with the use of it, although its staining properties are apt to be inconvenient.

Another method of using it is by means of "Dr. Delpech's *ouate picrique*, which is prepared as follows:—Purified cotton-wool is

* *British Medical Journal*, September, 1896.

steeped in a saturated solution of picric acid; the cotton-wool is then dried in a disinfecting stove; square sections of this cotton-wool, steeped in water, even in cold water, immediately relieves, and in a short time entirely abolishes, pain. Repeated applications of this wool, moistened, cure burns." A supply of this picric wadding would be a useful part of an ambulance outfit in works where burns were common.

Much shock is to be expected in extensive burns, especially in children. Prognosis in such cases is grave (see p. 81).

(7) **Treatment of Ulcers.**—The general indications for the treatment of ulcers are—(*a*) to purify the surface of the sore, and free it from irritation; (*b*) to stimulate the circulation of the part, if it be sluggish; (*c*) to remove obstacles to venous return; and (*d*) to treat any constitutional condition that may exist.

(*a*) Locally, foul ulcers in the skin should be dusted with iodoform, and dressed with lint, exactly fitting the sore, soaked in antiseptic lotion, and kept moist with oiled silk, which overlaps the lint all round with a ½-inch margin.

Should granulations become œdematous, and the healing be sluggish, stimulate the surface by touching it with blue stone (sulphate of copper), or by dressing with an astringent, such as 4 grs. to the ounce of sulphate of zinc. An ointment prepared from scarlet red is also very valuable in stimulating the healing process. It should not, however, be used for longer than one or two days at a time. Allantoin, an active principle prepared from the root of the common Comphrey has been used as a lotion for sluggish sores with great advantage.

Bright red, "healthy" granulations should, after being washed with a stream of boracic or weak lotion, be covered with oil silk or tin foil, over which is laid absorbent antiseptic wool, or boracic lint applied wet and allowed to dry, *in situ*.

The region of the ulcer should be kept as much as possible at rest. Thus, rest in bed is generally indicated in leg ulcers, especially if extensive. In the case of ulcers elsewhere, fixation of the part should be carried out by a splint. Where there is any tension on the base of the ulcer, as there generally is in large ulcers the surrounding skin should be relaxed either by the position of the part, or by drawing together the surrounding skin with long strips of plaster, passing near and, if necessary, over the sore.

Before removing the dressing from an ulcer, the whole should be softened by soaking with lotion, to prevent any part from sticking in.

(*b*) *Tertiary Ulcers* of gummatous origin, are generally benefited by free blistering round the sore, in addition to other treatment.

In *Callous Ulcers* the thickened brawny condition of the surrounding parts may be got rid of by various means, all of which, however, seem to act in common by stimulating the circulation and emptying the lymphatics; thus, free blistering of the surface of the sore and of the surrounding skin, firmly strapping the part, or compressing it

with an elastic bandage while the patient is walking about, or rubbing and kneading it once or twice daily and fomenting it with hot water, have each and all been found useful.

To strap an ulcer, strips of plaster should be cut, ½ inch wide and 3 inches longer than the circumference of the limb. The limb should first be bandaged nearly up to the ulcerated spot, then successive pieces of plaster should be applied, beginning just below the ulcer. Apply the middle of each strip at the part of the limb opposite to the ulcer, then bring either end forwards over the ulcer to over-lap in front of it. The bandage should afterwards be continued up the limb, well above the ulcer. Should the application seem too tight, relief may be given by carefully dividing with scissors the plaster opposite the ulcer. When removing the plaster in two or three days, si must be divided at this place, and carefully pulled forwards at each itde in one piece.

(*c*) The need for aiding venous return is almost exclusively found in ulcers of the leg, where varicose veins very frequently complicate, if they do not cause, the ulcerated condition. Rest in bed in itself aids venous return, and in many cases is alone necessary for a cure. Where such confinement is impossible, support to the limb with a firm domet, or an elastic bandage will sometimes suffice. Bandaging acts probably in several ways—*i.e.*, by supporting the venous walls when they tend to dilate, by aiding lymphatic absorption, and by stimulating the tissues by the mechanical pressure.

(*d*) The constitutional conditions most frequently complicating ulcers are the "strumous" and the tertiary syphilitic.

The "strumous" taint is best treated by good food, fresh air, and exercise, with cod-liver oil and iron (iodide or syrup of the phosphates), and malt extract taken internally.

In tertiary syphilis, salvarsan, or iodide of potassium (5 to 15 grs. thrice daily), is generally indicated, but in cachectic cases, a treatment more like that for "strumous" patients will be found best.

Any other general derangement complicating an ulcer, must, of course, be treated; thus the liver and bowels may require regulation, or dyspepsia call for special diet. A weak heart must be strengthened, and the system generally braced up.

(8) **Skin-Grafting.**—To further the cicatrisation of large granulating surfaces, epithelial grafts may be used. In order to attain good results, it is necessary that the granulating area be healthy and aseptic. The skin from which the grafts are taken should be first purified—that of the thigh or arm is usually selected.

The method of Thiersch is carried out as follows:—Local anæsthesia with Novocaine and adrenalin (p. 26), or general anæsthesia, should be employed during the cutting of the grafts, as this procedure is very painful. The grafts may be laid on a fresh raw surface, on a surface prepared by scraping away unhealthy granulations, or directly on the surface of granulations if they are healthy. If scraping be necessary, this should be done first, and a sponge or pad of gauze is bound over the surface to stop the bleeding while the grafts are being cut. The

integument which is to supply the grafts is well washed with salt solution to get rid of the antiseptic, and the operation proceeds. The skin is drawn tight. A keen razor is entered at right angles to the skin, so that it barely draws blood, and with a rapid sawing motion it is carried parallel to the free surface, shaving off a very thin strip of epithelium, which then lies upon the razor blade. This is transferred to and spread out upon the sore, either directly or after having been placed in warm normal saline solution, and a series are applied until the entire surface is covered with slightly overlapping sheets of epithelium. A convenient way of keeping the grafts in their place is to lay a piece of dry muslin over the wound and fix it with collodion to the skin, a little beyond the edge of the ulcer. The muslin remains in position for four to six days, and over it is laid a dressing of tin-foil, silver-foil, or oiled silk, with gauze or wool over all. This dressing may be changed without disturbing the grafts. The thigh should be dressed in a similar fashion. The extremely thin layer of skin removed leaves a surface which is bedewed with a slight ooze of blood ; healing takes place with extreme rapidity, and the patient suffers no inconvenience. The conditions should be aseptic rather than antiseptic, since the least amount of irritation gives the best result.

Direct Transplantation of Skin.—A pattern of the surface which requires covering should be drawn on the skin. The part removed should include *all* the layers, and the fat adherent to its deeper parts must be carefully removed with curved scissors. The prepared skin is now bound down under a dressing to the bare area rawed for its reception. The wound left by the removal of the skin must be purified, and drawn together with button and secondary sutures (*vide* p. 36).

Caution.—Syphilis, tubercle, and small-pox have been transferred by skin grafting. The skin may be taken from the recently amputated limb of a young healthy person, or from the body of a freshly killed animal. Excellent results have been obtained by using the skin of the abdomen of a puppy (*Miles*). A smooth-haired animal is preferable, but is not essential. The animal is chloroformed in an adjacent room till dead. The selected part of skin is then shaved, purified, and dissected up, being freed from subcutaneous fat as far as possible. The skin may then be placed in warm boracic lotion, carried to the wound, and applied in strips of about 2 inches by ¾ inch. If the granulations are healthy, Miles does not find it necessary to remove them, hence the patient need not be anæsthetised.

More extensive methods of grafting, where a pedicle of unsevered skin maintains the vitality of the graft till it has united with its new environments, do not come within the compass of the present work.

(9) **Sinuses**, or discharging channels which refuse to finally close up, owe their existence to some local or constitutional cause. They may thus be due to a piece of necrosed tissue, bone, tendon, or gland

lying deeply to an unabsorbable ligature, to want of rest, or to a tubercular or syphilitic condition of the lining granulations. The treatment will, therefore, be to remove the dead tissue, scrape away the diseased lining, purify with antiseptics, keep the part at rest, and improve the patient's constitutional condition. In the case of extensive sinuses connected with bones or joints, Beck's method of injecting with bismuth and vaseline, and afterwards taking an X-ray photograph, should be employed (see *Appendix*).

(10) **Erysipelas** and **Erythema** are, fortunately, much rarer since the introduction of antiseptics than they were a few years ago. They are still liable to appear in surgical wards, however, as patients with wounds septic, though not erysipelatous on admission, may develop erysipelas after they have been in the ward for a few days, while other patients, who have had previous attacks of the disease, are liable to have it again in their wounds, although apparently there has been no fresh infection.

It is most important to remember the extreme contagiousness of erysipelas, and to take the most rigid precautions to prevent it from spreading. No case of erysipelas should be admitted within the precincts of an ordinary surgical ward, and every patient that shows signs of the disease should at once be removed to an isolation-ward, kept specially for the purpose. The bedding should then be purified, and the bed (as well as wall and floor near it) sponged well with carbolic before it is returned to the ward.

When circumstances demand that a surgeon should dress erysipelas and other cases on the same day, the latter should be taken first, and in dealing with the former—besides attention to scrupulous cleansing and purification—the surgeon should wear rubber gloves and a clean linen over-all, by which he protects his clothes, and so reduces to a minimum the chance of his carrying organisms away with him.

Erysipelas connected with wounds requires that the wounds be treated on general principles, especially providing for free drainage and washing out with antiseptics. The reddened surface of skin before being wrapped in cotton wool should be painted with tincture of iodine, which generally relieves the burning pain complained of. Ichthyol ointment (20-50 per cent.) is also a most useful application. Watch must be kept for subcutaneous suppuration, and incisions made as soon as it appears. Generally milk diet is indicated. In bad cases, careful nursing and feeding at short intervals are of the utmost importance. Unduly high temperature may be reduced with the ice cap, or antipyrin. Quinine may be tried, but it often sickens. Free stimulation will be required in asthenic cases. Perchloride of iron in large doses has been vaunted.

(11) **Whitlow** is the name given to a cellulitis which often attacks the fingers, and frequently spreads up the sheaths of the tendons to the forearm. When seen in the early stage, the pain and throbbing should be treated by passive congestion. When, in spite of this, inflammation proceeds, it should be treated by warm antiseptic applications, with early and free incisions as soon as suppuration

seriously threatens. If the pus has burrowed into the forearm before the surgeon has been consulted, his duty will be to ensure free escape of pus and to put the forearm in a splint. In bad cases, irrigation or continuous immersion is indicated.

(12) **Treatment of Acute Inflammation by Passive Congestion.**— Bier has strongly recommended passive congestion as a curative agent in acute suppurations and inflammations, and has treated acute abscess, furuncles, cellulitis, inflammations of joints, and even osteomyelitis, in this fashion with success. A Martin's rubber bandage is applied lightly two or three times around the limb, well above the inflammatory focus, till a powerful passive congestion is created. Thus, in case of the hand or foot the bandage is applied to the upper arm or thigh. The bandage must *on no account cause pain*. A fiery red œdema and swelling is produced, extending over the whole limb below the level of the bandage. The bandage is kept on in general for at least ten hours daily. In severe cases it is employed for twenty to twenty-two hours. Between the applications the limb is laid in an elevated position, and dressings may then be changed. Blisters forming indicate that the bandage is too tight, or may mean that an abscess forms, which must, of course, be opened. The position of the bandage may be altered, and it may be slightly padded with gauze if it cause inconvenience or threaten the skin. A rapid relief of pain and fall of temperature ensue. Special suction apparatus has been used where parts were affected to which the bandage could not be applied (Klapp's Glasses).

(13) **Blisters** may be considered as the result of so rapid an effusion of fluid into the superficial parts of the skin, that the epidermis is raised up by it. Frequently they are caused by mechanical irritation, such as the friction of the feet in walking, or of the hands in rowing; but they may also be formed by superficial burns, or from the application of blistering fluids, or as the result of severe bruises, or in fractures. They are frequent in erysipelas and are seldom absent in inflammatory gangrene.

Their treatment will vary with their cause. *Blistered feet* may be prevented by avoiding the too sudden beginning of long walks; by hardening the skin by bathing it in solutions of alum or of chromic acid, 10 per cent.; by using well-fitting thick-soled boots; wearing woollen socks, and by smearing their surface with thin layers of soap, shaved off with a pen-knife, and laid on the inside of the stocking before starting for a long walk.

When blisters have formed, they should be pricked with a needle and the part protected from further irritation, if not by rest, by covering the part with protective soap plaster, or, if nothing else be available, a thin layer of soap.

Blistered toes may be wrapped with lint or oilsilk; but care must be taken to prevent such wrappings from working loose, and so causing more irritation than before.

Blistered hands must be treated in a similar way. Should any blister have suppurated or be much inflamed, the epidermis over it must be clipped away, and a moist antiseptic (such as 1 to 40 carbolic) dressing applied.

Small blisters from burns or from blistering fluids should be snipped, and covered with boracic or zinc ointment (see also *Burns*, p. 43).

The blisters of bruises or of erysipelas should be snipped, if large, dusted with powdered boracic acid, and covered with absorbent cotton-wool.

In gangrene, the blisters are forgotten in the seriousness of their cause.

CHAPTER VI.

ARREST OF HÆMORRHAGE.

Contents.—General Principles of the Arrest of Hæmorrhage—"Natural" and "Artificial" Arrest—**A. Primary Hæmorrhage**—Temporary Closure of Bleeding Vessels by the Tourniquet, Elastic Bandage, or Elastic Band—"Bloodless" Method of Operating—Varous Applications of the Tourniquet—Permanent Closure of Divided Vessels by (1) Ligatures; (2) Torsion; (3) Acupressure; (4) Forcipressure; (5) Pressure with Pads; (6) Suture of Blood-vessels; (7) Use of Heat and Cold, Cautery, Styptics, etc.—**B. Secondary Hæmorrhage—C. Reactionary Hæmorrhage.**

General Principles of the Arrest of Hæmorrhage.

Although it is not within the scope of the present work to discuss points of surgical pathology, still a reference to the phenomena that have been traced in the closure of divided blood-vessels will greatly help us to understand the various means which surgeons have devised to stop bleeding in wounds, whether it occurs at the moment of injury, or during the after-process of healing.

Stated in general terms, every method of arresting hæmorrhage ("natural" or "artificial") involves (1) an immediate blocking of the vessel's mouth by some mechanical obstruction not involving minute tissue changes; (2) a sealing of the end or ends of the vessel by plastic lymph, becoming afterwards (by a larger preponderance of cells and the development of capillary blood-vessels) granulation tissue; and (3) a process of circatrisation, by which the ends of the vessel are firmly closed by permanent and fully formed tissue.

Although for convenience of description, these stages are separately described, it must be remembered that they pass insensibly into one another and, so to speak, over-lap. From the moment that the vessel is wounded, and the mechanical obstruction is applied to preserve the patient's life, the vital processes which produce the second stage begin to act, and probably long before the whole mass of granulations has been fully developed, parts of it have begun to form the final cicatricial tissue. As the conditions brought about in the two later stages belong to processes which involve active changes in the tissue

themselves—processes which, for want of a better word, we may call vital—it is not unnatural to expect that these two stages will be very much alike under all circumstances, and in whatever varied ways the conditions necessary to the first stage may have been brought about. And, indeed, the more accurately the processes involved in the healing of vessels are studied, the more distinctly does this come to be recognised.

Leaving aside here the discussion of the many abstruse questions included under the general terms in which the two later stages have been stated, we may return to the first stage, and see how its conditions may be carried out.

The "Natural" Arrest of Hæmorrhage.—If we confine our attention to Arteries, in the "Natural" arrest of Hæmorrhage —*i.e.*, in the cessation of bleeding which occurs when the parts are simply left to nature—the details of the process vary somewhat according to whether the vessel be cut only *partially* or *entirely* across. In the latter case, the artery contracts at the point of division, and at the same time retracts within its sheath in virtue of the state of elastic tension in which it normally lies. The blood, as it spurts from the open mouth of the vessel, deposits itself in the form of blood-clot, partly in the now empty sheath, and partly in the surrounding tissues of the wound. This clot gradually increases, forming layer by layer from the blood as it flows, until, if the vessel be a small one, say, a digital artery, the extrnal plug so formed, in addition to the contraction of the coat, stops the bleeding. Should the vessel be a large one, say, the femoral, the current of blood will sweep away any clot that forms, and the patient will rapidly bleed to death, unless other aid be at hand to save him. Again, should the vessel be a medium-sized one, say, the radial, although the clot will be swept away at first, the rapid loss of blood will cause fainting, and during the period of enfeebled circulation which exists while the fainting lasts, a clot may have had time to form, large and firm enough to resist further bleeding when consciousness, and with it quickened circulation, returns.

After the mouth of the vessel has been closed by this external clot, a thrombus or internal clot forms inside the vessel, and, extending up within it for a variable distance, still further resists the force of the blood-stream, although it probably is not in itself quite sufficient for that purpose.

In the "*Natural*" *arrest,* therefore, when the vessel is divided across, the mechanical agent is the contraction of the vessel and the presence of an external blood-clot aided by an internal one.

Should the artery be only *partially* divided, the retracting tendency makes the wound in the vessel gape the more, so that the outer clot has less chance of forming than if the division had been complete. Under favourable circumstances, however, the clot does form. and unless the current be so strong as to make it

yield and produce a false aneurism, the processes of healing will go on as in the first case.

When an artery, instead of being cut across, is torn, twisted, or bruised across, its inner and middle coats are curled up inside the outer one, and so, by blocking the lumen, stop the bleeding; when, in addition, the outer coat is either twisted or drawn out into a fine thread, the occlusion is still more complete. Moreover, when the inner coat is injured, the internal clot or thrombus forms more strongly, and acts more efficiently in closing the vessel, than when it is divided by a clean cut.

The "Artificial" Arrest of Hæmorrhage.—In "*Torsion*" and "*Forcipressure*," therefore, whether deliberately performed by the surgeon, either directly with forceps, or indirectly by the use of the ecraseur, or cold snare, or accidentally done by the violence of machinery, the mechanical or occluding agent is the twisted, bruised, or torn ends of the broken vessel, aided by the formation of an internal clot.

In a *Ligature* as usually applied, the mechanical agent is the tight band round the tough outer coat, after the inner and middle coats have given way and have retracted. An internal clot is also formed in this case, but is not of great service in maintaining the occlusion. The pressure of the ligature soon causes the outer coat to soften and atrophy, but simultaneously there advances the natural sealing process by the formation of plastic lymph and granulation tissue. In the old days of septic wounds, the silk ligature, being saturated with organisms, was a source of irritation to its surrounding granulations, and became loosened by making them suppurate. If the suppurating or liquefying process went too far into the sealing mass, the vessel was opened again, and secondary hæmorrhage, formerly very common, was the result. In aseptic wounds, on the other hand, the ligature of catgut, silk, or other suitable organic material, is absorbed by the granulation cells, and disappears without any suppuration at all. The risk in these cases is the softening not of the sealing mass, but rather of the ligature, or of its slipping before the sealing mass is ready to take its place: or, on the other hand, in a large vessel, the risk lest the sealing mass—even when fully formed—should not have a consistence strong enough to resist the pressure of the blood-stream.

Some surgeons have recently urged a return to a method which was advocated, but given up prior to the introduction of antiseptics—namely, the application of the ligature—so as to obliterate the lumen of the vessel without rupturing its coats. For arteries not larger than the superficial femoral, this method is not called for, as the usual method is perfectly safe under antiseptic precautions, and easier to apply. For larger vessels, the non-rupturing method is preferable; Burrell of Boston, for instance, ligatured the innominate artery with silk with two ligatures placed half an inch from one another. The proximal one was drawn tight and the

coats of the vessel gave way under it, the distal ligature, although not drawn so tight, yet caused some rupture of the coats. The patient lived to the 104th day and died of heart failure. The proximal ligature had cut its way through the coat of the artery without causing hæmorrhage, and was found inside the restored lumen. The distal ligature had led to complete obliteration. The wound had remained aseptic.

Ballance and Edmunds, after discussing the merits of the various ligature materials available for large vessels, conclude thus: "The choice then must fall on ox peritoneum, kangaroo tendon, or boiled floss silk; and failing these, on boiled Chinese twist, chromic catgut, or silk-worm gut." They strongly recommend the use of what they have called a "stay knot" (Fig. 7). This consists in a double thread

Fig. 7.—"Stay Knot" (after Ballance and Edmunds).

passed round the artery; each portion is tied separately in the first stage of a reef knot, then the two ends on either side are taken together and treated as one, to complete the reef knot.

When *External Styptics* are used, the mechanical agent is probably either (1) a firmer than natural clot induced directly by the hot iron, caustic, or chemical agent, or indirectly by the altered state of the surrounding tissues; (2) an occlusion of the mouth of the vessels by shrivelling and spasm either of the surrounding parts, of the vessels themselves, or of both. When internal styptics are used, either the coagulability of the blood is increased, or a condition of temporary anæmia of the part is caused by local spasm of the arterial walls, producing a result like that occasioned by the general slackening of the circulation in fainting. One or all of these conditions may be present in the use of different agents, their exact action, however, in the case of many known to be useful is not certain.

If we have clearly grasped the general principles involved in the above sketch, we shall the more easily be able to understand what the various kinds of hæmorrhage are, and be better prepared to apply intelligently the practical rules devised to meet them.

Three kinds of hæmorrhage have been recognised by surgeons:—(1) Primary, that which occurs at the moment of division of the

blood-vessel; (2) Reactionary, that which appears on the return of quickened circulation after a collapsed condition—*i.e.*, within six or eight hours of the injury; (3) Secondary, that which occurs during the process of healing of the vessel.

A. Primary Hæmorrhage.—During an operation, bleeding may be avoided by temporary pressure on the main vessels leading to the part, with subsequent closure of the wounded vessels by ligature, torsion, styptic, or cautery. In other cases, the vessels, as they are being divided, may be closed by the use of the ecraseur or cautery; or, again, the vessels may be exposed and seized with forceps before they are divided, being permanently secured immediately afterwards.

The Temporary Pressure must be carried out differently in different parts of the body. In the extremities (unless when close to the trunk) the main vessel can be secured by the pressure of a tight band, applied by a tourniquet, elastic bandage, or elastic band.

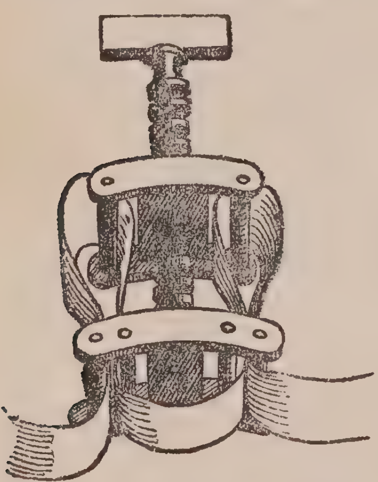


Fig. 8.—Petit's Tourniquet, to show use of Rollers.

(*a*) The **Tourniquet** in use now is only slightly modified from the original instrument devised by Petit. The instrument is in such frequent use that a description of it would be superfluous.

The following points must be attended to in applying the band to the tourniquet:—(1) The receiving side of the buckle must be towards the limb, and about 2 inches of band must be left between the buckle and the first roller; (2) the band must pass only over the rollers of the plates, so that when the instrument is ready nothing should be seen from below but the brass margins (Fig. 8); (3) lastly, before being handed to the operator, the two plates should be screwed close together.

A pad is generally used with the tourniquet, and is applied differently by different surgeons. Usually the pad, in the form of a medium-sized roll of cotton bandage is placed over the main vessel of the limb, and over this in turn the lower screwplate; when so applied, the pad serves the double purpose of increasing the pressure on the main artery and preventing the skin from being nipped up as the tourniquet is tightened. Sometimes the screw and pad are moved to that part of the limb where the screw can be most conveniently reached, leaving the general compression of the band to close the artery; while, at other times, the pad is placed over the artery, but the screw moved away from it, in which case either a second pad or a bandage round the limb must be used to prevent the nipping of the skin. Any of these methods will serve the purpose. Except below the knee, where the first seems best, we prefer the second method.

(*b*) **Elastic Bandage.**—For the limbs of children or of thin and emaciated persons, we prefer, what Esmarch recommends, viz., a few turns of a broad elastic bandage, as it controls the vessels without risk of injuring their walls, or of bruising nerves and muscles.

(*c*) **Elastic Band.**—Esmarch has advocated the use of a strong band of elastic tubing or cord, applied while stretched once or twice round the limb. A diameter of about $\frac{3}{4}$ inch is used for the thigh, and one or two smaller sizes for the leg and arm and for the fingers respectively. Foulis' catch (Fig. 9) is a good one, but the simplest

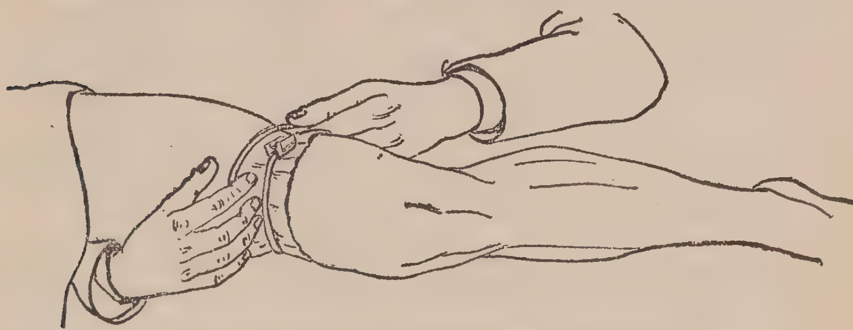


Fig. 9.—Application of Elastic Tourniquet.

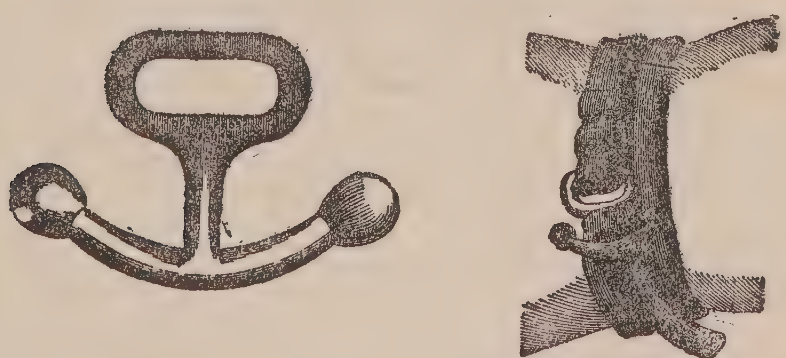


Fig. 10.—Samways' Anchor-shaped Catch.

and most convenient for rapid fixing and unfixing is Samways' anchor-shaped catch (*Down Bros.*) (Fig. 10). A turn of bandage, to protect the skin, should be applied before the band is put on.

To apply the Elastic Band, begin at the end near the catch, and having encircled the limb with the stretched band, hold the ends together with the finger and thumb of the left hand, while the right is passed round the limb for the second pull (Fig. 9). Secure the last turn in the catch.

N.B.—Whatever form of constricting band or tourniquet is used, care must be taken to compress the main artery at once. If the venous return is impeded while arterial flow continues the limb will become engorged with venous blood, which will be lost when the vessels are divided.

The great advantage of the tourniquet (especially where there are few assistants) is the possibility of easy relaxation and tightening of which it permits. After an amputation, the main vessels can be picked up and tied; then, by relaxing the tourniquet, some previously unnoticed vessels will be found by their spouting, and secured while the tourniquet is screwed up again. The process may be repeated as often as desired. In the interval many smaller vessels will become occluded by the blood-clot which has thus an opportunity to form. When the elastic band or bandage on the other hand is slackened, it cannot be so easily re-tightened, because several turns round the limb are generally required.

The "Bloodless" Method of Operating.—A method of operating, known now as the "bloodless" method, was taught in Edinburgh many years ago by Lord Lister, and was afterwards independently advocated by Professor Esmarch of Kiel. The object of this method is to empty the limb of blood before the tourniquet is applied, so that the part to be operated upon may be bloodless. Lord Lister raised the limb vertically, while the patient is lying horizontally, this in itself is generally sufficient to blanch the limb in a few minutes; but the process may be hastened by compressing the main artery, and encouraging the venous return by a few passes of the hand towards the trunk. The tourniquet, or elastic band, must be applied while the limb is still vertical. Professor Esmarch produces a similar effect by bandaging the limb, from the extremity upwards, with an elastic bandage, thus forcibly driving all the fluids out of the limb Before relaxing the bandage, he compresses the main vessels with an elastic tube, which effectually prevents the return of blood. During an operation, the "bloodless" method permits of the most perfect inspection of the part; but in proportion to the thoroughness of the process, and to the length of time it has been maintained, is the intensity of the hyperæmia which follows the return of blood. On this account, the oozing which at first occurs from innumerable small vessels is apt to cause a greater loss of blood to the patient than when the ordinary method is carried out, so that the term "bloodless," from the patient's point of view, is far from applicable. To obviate this inconvenience, as many vessels as possible should be secured before the blood is allowed to return; then a sponge should be pressed into the wound, and the limb raised for a few minutes after the circulation is allowed to return. The congestion will soon pass off, and the remaining vessels can then be picked up and secured.

Lister's method is simpler, has no tendency to drive pus, blood-clot, organisms, or *debris* of a malignant growth into the general circulation, and being less complete, although sufficient for all purposes, is followed by a less intense congestion.

Special Modes of Control.—The application of an ordinary tourniquet to compress the vessels of a limb close to the trunk, or those of the trunk or head and neck themselves, is difficult or impossible. It is, however, generally possible to plan an operation at the hip, shoulder, or elsewhere, so that the main vessels can be exposed and ligatured as the first step of the procedure. This is especially necessary where there are few or unreliable assistants; still, special means for temporary control of the circulation may be adopted in particular cases, such as

(*a*) Close to the hip-joint, the vessels may be controlled by

(1) *Compression of the abdominal aorta* at its bi-furcation, either by an abdominal tourniquet, with its pad below and to the left of the

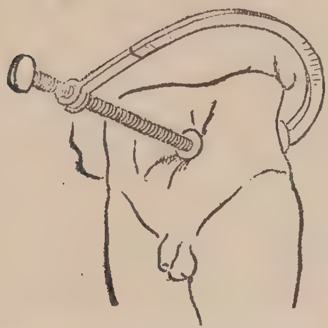


Fig. 11.—Lister's Abdominal Tourniquet.

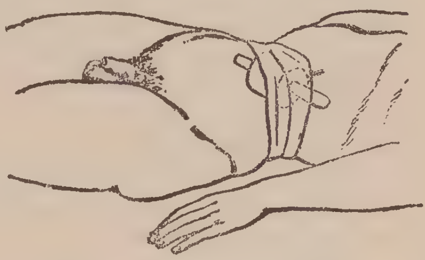


Fig. 12.—Pad and Elastic Band compressing the Aorta.

umbilicus, directed backwards, and a little inwards (Fig. 11), or by a large pad on the same spot, held in position by several turns of an elastic bandage or tube (Fig. 12). Momburg recommends the use of a strong elastic tube wound several times round the waist without any pad. His technique is (*a*) to see that the vessels are empty, (*b*) to ensure relaxation with anæsthesia before applying the band, and (*c*) where pelvic organs are involved to empty the lower limbs of blood first of all, then apply the abdominal constriction, afterwards allow the lower limbs to hang down so as to drain as much pelvic blood as possible into them, and to retain it there by an elastic constriction round each thigh till the end of the operation. This method has been carried out for forty-five minutes without harm. Professor MacEwen's method is as follows:—An assistant takes up the position in a line with the patient's umbilicus, which is indicated in the figure (Fig. 13).

Fig. 13.—Prof. MacEwen's Method (after MacEwen).

The knuckles of the right hand are placed on the abdomen, a little to the left of the middle line, the lowest knuckle—*i.e.*, that of the index finger—being at the

upper border or the umbilicus. He then leans in this way upon the lower part of the abdominal aorta, and with his left fore-finger on the femoral artery, first on one side, then on the other, gauges the pressure necessary to control the circulation. Pressure can be easily maintained for half an hour or longer without fatigue.

In none of these methods need the temporary compression of the retestines be feared. The real objection is rather the hindrance to inspiration, which in an enfeebled patient may seriously complicate anæsthesia.

(2) *Wyeth's Method of Elastic Compression with the help of pins* is an improvement upon a method introduced by Professor Spence. The patient is laid on his back, with his sacrum resting on the corner of the operation table (Fig. 14). To prevent the elastic tourniquet

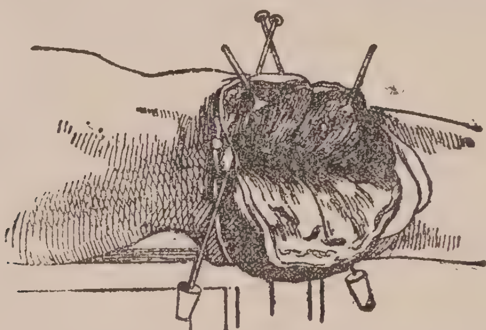


Fig. 14 --Wyeth's Method of using Pins in Amputation at Hip-joint (after Wyeth).

from slipping after the head of the femur has been disarticulated, two spear-pointed steel pins, $\frac{1}{4}$ inch thick and 10 inches long, are used. One is entered $\frac{1}{4}$ inch below and a little to the inner side of the anterior superior iliac spine, and is driven for 3 inches superficially through the skin and muscles, and brought out on the outer side of the thigh at the same level as its point of entrance. The other pin enters at a point $\frac{1}{2}$ inch below the angle of the symphysis, and after passing through the tendon of origin of the adductor magnus, is brought out $\frac{1}{2}$ inch below the tuberosity of the ischium. The points are guarded with pieces of cork (small pieces of metal tubing would be preferable). A pad of sterilised gauze 4 inches square and 2 inches thick is next laid over the femoral vessels where they cross the pubes. A strong india-rubber tube, $\frac{1}{2}$ inch in diameter (when unstretched), and long enough to go five or six times round the thigh, is then wound tightly round above the pins. Wyeth recommends that the main vessels should be ligatured before the head of the femur is disarticulated.

(3) Where the head of the femur can be left in position until the main vessels have been secured, bleeding may be controlled by an *elastic tube encircling the thigh*, and carried round the pelvis after being crossed above the great trochanter. To prevent it slipping down the thigh, two supporting bands should draw it upwards at the inside—one in front, and one behind. These may be secured round

the trunk or held by assistants (Fig. 15). A large pad and an elastic bandage may also be used to compress the external iliac (Fig. 16).

(4) *Digital Compression of the External Iliac* against the pubes in children, or in adults by a powerful hand, while the posterior vessels are being compressed by a pad over the sciatic notch. Most surgeons, however, prefer the security afforded by mechanical means.

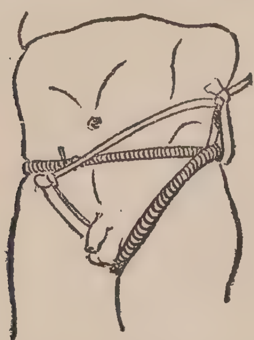


Fig 15.—Elastic Tourniquet applied for Amputation at the Hip-joint.

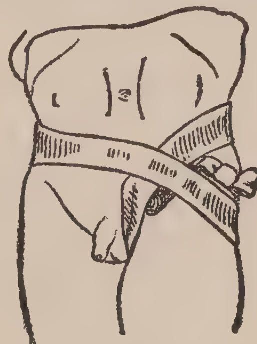


Fig. 16.—Elastic Band and Pad for Amputation at the Hip-joint.

(*b*) **Close to the Shoulder-Joint.**—Many *operations* can be *planned*, so as to allow the main vessel to be exposed and grasped before it is divided. The *third part of the subclavian* may be *compressed* against the first rib by a firm pad pressed downwards from above the clavicle by an assistant (Fig. 17). For this purpose, an india-rubber tipped compressor has been devised, but the handle of a door-key or other similar instrument, well padded, acts nearly as well. Keen recommends the following plan:—"A suitable roller bandage, 2 inches wide, is placed above the clavicle over the position of the artery as ascertained by the touch." Esmarch's elastic *bandage*, well-stretched, is then wound over it. In order to keep the pad from slipping down over the clavicle the bandage is made to pass from the front of the chest over the shoulder and down the back, then under the perineum to the front again, once or twice. One or two turns under the opposite axilla are used to prevent the pad from slipping outwards and downwards. Thus no assistant is required to keep the pad in place, but the elastic compression would tend to interfere with respiration. When the greatest security is desired, Mr. Syme's plan should be followed. In a case of axillary aneurism, the *skin above the clavicle was incised*, and the cellular tissue separated to allow an assistant's fingers to reach the artery itself, and hold it against the first rib. Where it is desirable to control the circulation after the shoulder

Fig. 17.—Compression of Subclavian with Compressor.

has been disarticulated, Wyeth's plan should be adopted. Two strong steel spear-pointed pins are used; each is $\frac{1}{4}$ inch thick and about 10 inches long. One transfixes skin and pectoralis major muscle at a point about 3 inches on the inner side of the shoulder—*i.e.*, just within the coracoid process. The other transfixes skin, deep fascia, and muscle on the dorsal aspect of the scapula, about the same level. Each pin is hidden in the tissues for

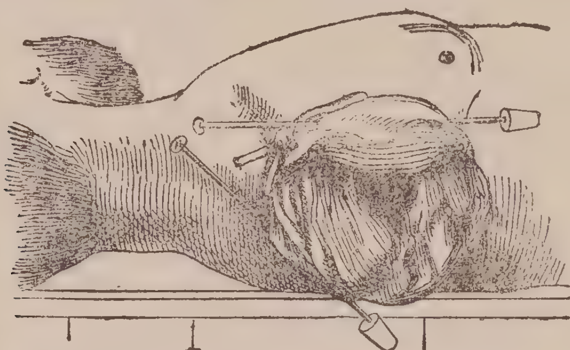
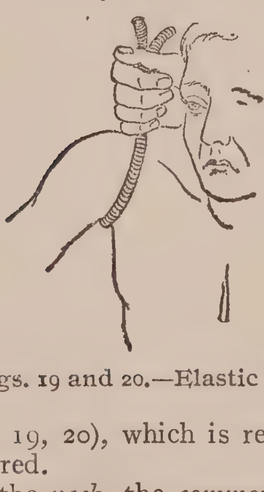
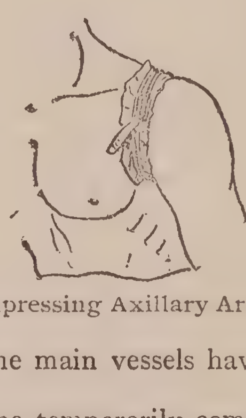


Fig. 18.—Wyeth's Method of using Pins in Amputation at Shoulder (after Wyeth).

about 3 inches, and their points are protected with pieces of cork or metal tubing (Fig. 18). After the limb has been rendered bloodless by Esmarch's band, a piece of india-rubber tubing, about $\frac{1}{2}$ inch in diameter, and long enough to go five or six times round the shoulder, is wound tightly round above the pins. This will remain in position after disarticulation of the shoulder is complete. Sometimes the axillary artery can most readily be controlled by elastic tubing





Figs. 19 and 20.—Elastic Tourniquet compressing Axillary Artery.

(Figs. 19, 20), which is removed after the main vessels have been ligatured.

In the *neck*, the *common carotid* may be temporarily compressed against the cervical vertebræ, by inserting the fingers beneath the sterno-mastoid and pressing directly backwards. The "carotid" tubercle—*i.e.*, the transverse process of the sixth cervical vertebra—is

the best position to take; but the operation is always a painful one. Owing to the freedom of anastomosis across the middle line, not much is to be expected from compression of the vessels of the face or scalp. Still, the *facial arteries* may be held against the lower jaw, just in front of the masseter; the *temporal arteries*, against the sides of the frontal bone, or upon the zygoma, just in front of the ear; and the *occipital arteries*, against the occipital bone between the external occipital protuberance and the mastoid process. The *coronaries* of the lip can be easily controlled by the grasp of an assistant's fingers, or by special forceps.

The *lingual arteries* may be compressed, as Mr. Christopher Heath advises, by passing the forefinger behind the tongue, and hooking the soft parts forward and inwards against the lower jaw. This may often be useful in an emergency.

Even where feasible, it would be inadvisable to apply any means for temporarily controlling circulation for longer than from four to six hours, lest the tissues should be so starved by want of nourishment, that they would inflame or become gangrenous when the blood returned.

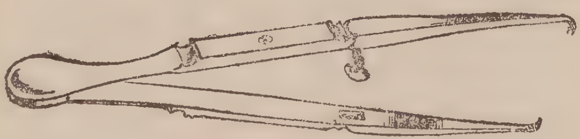


Fig. 21.—Artery Forceps (sharp pointed).

Permanent Closure of Divided Vessels.—The means at our disposal of immediately closing divided vessels are many:—

(1) **Ligatures.**—The mouth of the artery or large vein, being grasped with forceps, is slightly drawn out from its sheath, and secured by a ligature. Formerly, a curved needle on a handle or tenaculum was passed into or near the vessel, so that it might be raised; afterwards, sharp-pointed forceps were adopted with a catch to keep them shut (Fig. 21), these being subsequently improved, so

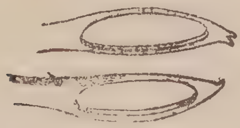


Fig. 22.—Fenestrated Artery Forceps.

Fig. 23.—Péan's Forceps.

as to make the thread slip better over their end (Fig. 22); while, more recently, pressure forceps have been introduced, of which there are many modifications of Kœberle's original pattern. The best are, perhaps, the strong conical-ended forceps, known as "Wells' forceps," from their having been modified by Sir Spencer Wells; although many similar instruments, such as Péan's (Fig. 23), Tait's, Greig Smith's, or Kocher's are in use, according to the taste of the surgeon.

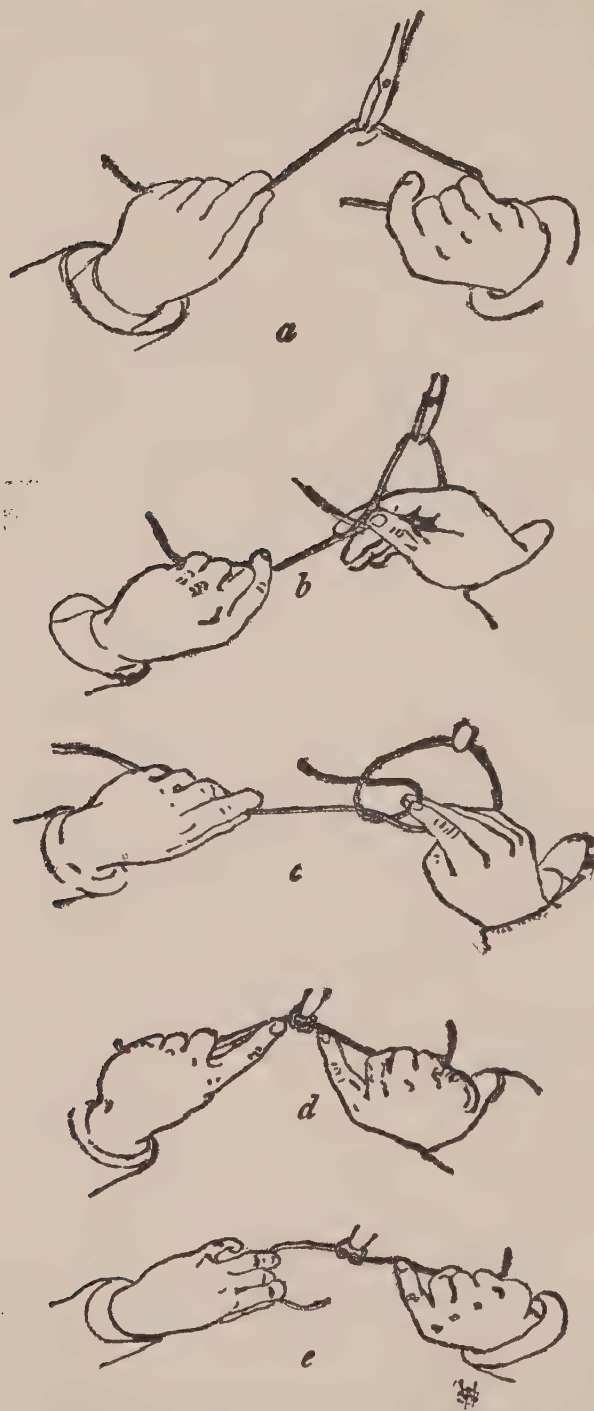


Fig. 24 —Tying the Reef-Knot, first method.

In order to facilitate thorough cleaning, most patterns of forceps, as indeed of other two-bladed instruments, are now made so that the blades can be detached at pleasure.

During the progress of an operation, the mouths of bleeding vessels can be secured by these pressure forceps as they are divided, or just before it, if the vessels can be seen, and the surgeon may proceed with his work, leaving, perhaps, ten or twelve pairs of forceps hanging on to the surface of the wound. In a few minutes he may return to the forceps, and find, after tying the larger vessels, that the squeezing of the smaller ones has completely closed them.

Tying of Arteries.—In tying the arteries, the forceps should be drawn by an assistant, obliquely away from the person who ties, as soon as the ligature has been passed round the artery (Fig. 24). As the first knot is being tightened, the handle of the forceps should be lowered more and more on the side away from the knot, to lessen the risk of including their points. On the knot side, the operator's fore-fingers ensure that the thread passes well over the forceps. When the thread thus guided on to the soft parts alone is being firmly drawn, the forceps must be slipped off, so as to allow of addi-

Fig. 25.—The Reef-Knot.

Fig. 26.—The Granny.

tional tightening. The second knot may then be made, and a third, if necessary. Although a single turn is generally sufficient, a double turn, although more difficult to tighten, lessens the risk of slipping before the second knot is made, and may sometimes be needed. From time immemorial, the reef-knot has been advocated as imperative lest the thread should slip, and it ill becomes us to discredit this practice. We shall only say, however, that sailors prefer the "reef"-knot (Fig. 25) to the "granny" (Fig. 26), less because the former is more secure, than because it can be undone more easily by drawing one of the free ends back towards the other. The difference between the two knots is in the second twist. If each end, after being twisted round the other once, be brought back on itself past the other before being twisted a second time, the "reef" will be formed. If they crossed over at once, the "granny" will be the result.

Two simple ways of ensuring the constant formation of a reef-knot are illustrated by the Figures 24 and 27 respectively, where the operator is supposed to be looking at his own hands. In each method the work is done in the same way by each hand alternately. To begin with, the ligature being held in the right hand is passed round the forceps to the left hand. In the method shown in Figure 24 the right hand is prone as it grasps the ligature, the free end of which

points to the left and is at the radial side of the right hand (*a*). The right hand is then supinated, but in such a way as to keep the ligature still pointing to the left. Next the left hand brings its end over that in the right hand and places it between the fore and middle fingers of the right hand which then grasp it (*b*). The left hand then lets go its own end and grasps the other one. In this way the ends of the ligature change hands. The right hand then draws on the end which lies between its index and middle fingers and pulls it through so as to form the first stage of the knot (*c*). The knot is tightened by the ligature being firmly held by the ring and little fingers of each hand while it is guided over the forceps and strained transversely by the forefingers (*d*). At this stage the forceps are taken off by the assistant so that the knot may be fully drawn in. When this has been done the second stage of the knot is begun by the left hand grasping its end of the ligature exactly as the right hand originally did (*e*). After this the process is the same as before only with the left hand replacing the right and *vice versâ*.

In the method shown in Fig. 27, the right hand is supine as it

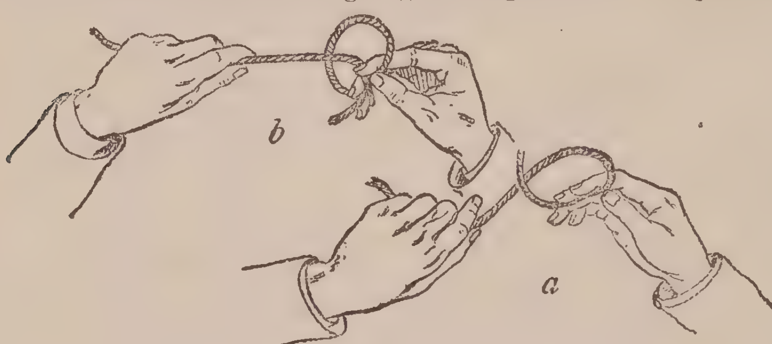


Fig. 27.—Tying the Reef-Knot, second method.

grasps the ligature, the free end of which, also pointing to the left, is now at the ulnar side of the hand (*a*). The right hand now remains supine while the left hand brings its end behind that held in the right hand and then across and in front of the same. The left hand next places its end between the fore and middle fingers of the right hand which then grasp it (*b*). After this the left hand lets go its own end and grasps the other one, and so on as before. Either method is equally good.

When working in a cavity, the use of the forefingers as pulleys, to make the strain transverse, and so prevent the knot from being pulled off the vessel (Fig. 24, *d*), is specially important.

The ligature should be a foot long, to permit of this firm grasp.

It is not necessary to tie the smaller vessels on the face of an easily accessible wound with the same care as a main vessel, or a smaller one in a cavity. Joseph Bell employed a long ligature, which he held in his left hand, and used repeatedly; saving both time and ligature. The ends do not change hands, and the shorter one in the right hand

is passed round the other (alternately over and under), and is always grasped again by the same hand. In practice the method answers well. In drawing on the first twist, the hands should be crossed,* and the thumb of the right hand used like the forefinger to guide the thread. This in an open wound is no objection. The single long end remains coiled up in the left hand, or twisted round the left little finger.

Facility in tying arteries is an important accomplishment, and saves much time in an operation. Every young surgeon should practise the art with string on a piece of cloth, until he can do it without effort—reflexly, or in the dark. When a large artery is tied in its continuity, the knot must be a "reef," firmly and securely fastened with, perhaps, two or three extra turns.

For methods of preparation of catgut, see *Appendix* **L.**

(2) **Torsion.**—For the smaller vessels, all that requires to be done is to seize the open mouth with pressure forceps (Fig. 20), or special torsion forceps (Fig. 21); draw it out a little, and twist it four or five times round—some say, until it breaks off, but this is not necessary. Larger vessels may be steadied after being drawn out by one pair of forceps, while they are twisted three or four times round with another pair.

Experience has shown that torsion is a perfectly safe method of closing even the largest vessels. However, for large vessels anywhere, and for smaller ones, unless when lying in unusually lax tissues (as in the scrotum, or beneath the mucous membrane of the rectum), ligature under antiseptic precautions with absorbable material, is equally efficient and more rapid, as obviating the need for so carefully isolating the vessel.

A modification of the torsion is forcible pulling out. Victor Horsley, in excising the thyroid gland of monkeys, seized the arteries, and drew them out from the gland, until they tore away. The broken vessels were in this way simultaneously divided and closed, and gave no further trouble. Under certain circumstances, this method might be useful.

(3) **Acupressure** has now fallen almost entirely into disuse. It was introduced by the late Sir J. Y. Simpson to obviate in a decomposing wound the irritation of silk threads, which only conducted the septic mischief closer to the wounded and healing artery.

One of the methods employed may be sometimes useful on the scalp, or in the face, where there is difficulty in finding the wounded vessel, and where further cutting is undesirable. This method consists in passing below the vessel, at a little distance from the wound, a needle, round whose projecting ends a loop of wire or silk is afterwards wound, so that the artery is compressed between the needle and the silk.

(4) **Pressure with Forceps.**—In cases where large vessels have been either cut across or partially divided and in which for any

* Even if the hands be not crossed the first time, the knot will be drawn properly the second time.

reason a ligature or suture cannot be applied, or relied upon, the bleeding may be arrested by applying pressure forceps and leaving them in position for twenty-four to forty-eight hours. This method has sometimes been employed in bleeding from the tonsil, in deep operation wounds in the pelvis, and even in wounds of the abdominal aorta and inferior vena cava.

(5) **Pressure with Pads** directly over the wounded vessel will stop the bleeding in any artery, although, owing to the simultaneous pressure upon companion-veins, and on other structures, the method is inconvenient. Wounds of any of the palmar arteries are frequently treated by graduated pressure, although general pressure often succeeds as well. The arteries of the palm are difficult to reach, and lie close to large nerves; moreover large cicatrices are undesirable there, hence the need for pressure. *Graduated pressure* is produced by a series of successively larger pads of lint, beginning with one that just fits into the wound, until a conical plug is formed. This, when bandaged in place, presses upon the wounded part, and generally stops the bleeding. At the same time the circulation in the hand should be lessened, by firmly bandaging the forearm, by placing pads over the radial and ulnar arteries at the wrist, by flexion of the forearm, and by raising the hand by fixing it at the opposite shoulder.

The pads used in the wound should be soaked in antiseptic lotion. They should be removed in twenty-four or thirty-six hours, and equable pressure over the wound be substituted. When possible a firm flat pad over the wound should be used from the beginning, as it permits of closure of the wound, and if successful, obviates the risk of an outbreak of the bleeding, such as may occur when the graduated pad is removed.

All that has been said of the palm of the hand applies equally, with the necessary modifications, to the sole of the foot.

Veins must be ligatured like arteries when they bleed, or may be expected to bleed. Pressure by pads is useful in dealing with bleeding from large veins where a ligature cannot be applied. For instance, in removing tuberculous glands from the neck, the surgeon sometimes tears or cuts a hole in the internal jugular vein near the skull. He must at once put his finger on the bleeding spot, and having made ready the necessary strips of gauze replace his finger by firm packing made large enough to fill up the wound and be held in position with a bandage round the head and neck. It must not be disturbed for several days—although the outer dressings way be changed.

(6) **Suture of Blood-Vessels.**—For longitudinal, oblique, or transverse wounds of large arteries or veins which are accessible, suture is advisable, so long as the injury does not exceed half the circumference of the vessel. The circulation must be temporarily controlled without injury to the vessel wall by light clamps or pad pressure. The finest needles must be used, and those made with spring eyes are to be recommended for convenience in threading. Very fine silk or linen thread must be soaked in sterile vaseline.

In applying the stitches the endothelial surfaces must be everted, and so brought in contact with one another with a continuous stitch. This is made easy by the insertion of preliminary stitches, one at either end of the wound in the vessel. Each stitch is grasped with forceps and drawn away from the other, so as to make the suture line tight.

End to end anastomosis of blood-vessels requires a more complicated technique and must be studied in special articles or treatises.

(7) **Use of Heat and Cold.**—As the result of experiments on vessels and muscular tissue of the uterus of rabbits, Milne Murray has shown * that—

"(1) Water, at a temperature of 120° F. and 10° lower, contracts blood-vessels, and arrests hæmorrhage from small arteries.

"(2) Water, at a temperature of 100° and 30° or 40° under, dilates small vessels, and promotes hæmorrhage.

"(3) Water, at temperatures of 50° F. and 20° under, check hæmorrhage by constricting blood-vessels, but this only temporarily.

"(4) After water at the above temperatures has lost its styptic power, water at high temperatures is still effective."

These experiments have been fully verified by clinical experience in postpartum hæmorrhage.

The more efficient and lasting effects produced by hot water—*i.e.*, at temperatures between 110° and 120° F.—as well as the diminished risk of its inducing shock by extracting heat, would lead surgeons to employ it in many cases where formerly cold was used. In bleeding from inaccessible cavities or deep wounds, for instance, the injection of hot sterilised water has been found of great service. Hot water has also the advantages of being generally more readily available than very cold, and, after it has been boiled, of being at least aseptic. The observations hitherto have been made chiefly directly on wounded surfaces and upon bleeding mucous membranes, which seem to stand without damage a temperature which would blister the skin. Sir Victor Horsley uses a stream of water between 110° and 115° F. to check bleeding from the cut surface of the brain. At a higher temperature he would fear injury to the delicate brain tissue. If we have to produce constriction of vessels at a distance below the skin by the continued action of either heat or cold, we should prefer the latter.

When temperatures from 120° to the boiling point and onwards are brought to bear on tissues, effects other than those produced merely by muscular spasm are seen. There is (besides injury visible only by its results) first coagulation of albuminous substances and softening of connective tissue; a higher temperature still more coagulates the one and hardens the other; while the temperature of dull red-hot iron coagulates and hardens all tissues, and kills them at the same time.

* *Ed. Med. Journal*, Sept., 1896.

Cautery.—The actual cautery is thus a most powerful styptic, as it, when properly applied, shrivels up all the tissues into a hard mass. The greater the heat, the more rapid and the more superficial its effect; so that if a blunt-edged blade be used white-hot, the vessels bleed nearly as much as if they had been cut across with a sharp knife; while if a dull-red or black heat be employed, the progress is slower, but the shrivelling and occlusion of vessels complete.

Pacquelin's thermo-cautery is used where vascular textures not easily accessible have to be divided (Fig. 28). It is also of service in searing the skin, or otherwise, where the actual cautery is required. In using this instrument, the knife must be heated to redness in the spirit-lamp before the benzoline vapour is blown in, otherwise the knife is only cooled by the cold blast.

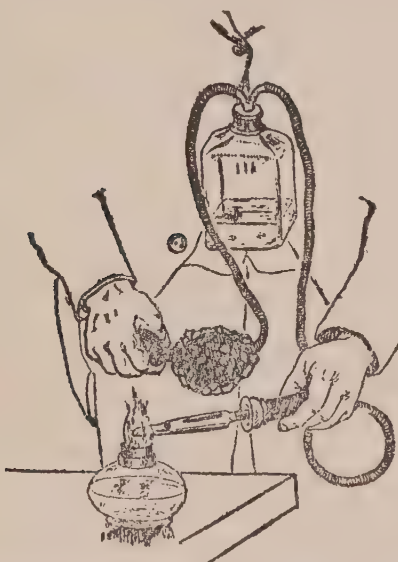


Fig. 28.—Pacquelin's Cautery. Heating the knife to redness before pumping in Benzoline vapour.

The galvano-cautery is advocated for cutting through the vascular base of polypoid growths, where direct access to the divided vessels is impossible, as in the removal of a fibrous polypus from the nasopharynx. From what has been already said, the advantage of using the wire at a dull-red heat will be apparent, but it has been found somewhat difficult in practice to regulate the heat.

Cold.—From almost time immemorial, cold has been used to check bleeding, and there is not the slightest doubt that cold does constrict blood-vessels. The effect of prolonged cold in producing pallor of the skin is well known, and probably was the clue that first led to its application to bleeding. Milne Murray's experiments seem to indicate that direct application of cold to bleeding parts induces a constriction at first, which rapidly passes off; but since prolonged cold to the extremities seems undoubtedly to maintain pallor, it is probable that some of the special effects of cold upon the skin depend upon its action through the nervous system.

When a lowered temperature is desired, we rely on two methods of obtaining it—*ice*, for direct and indirect effects, and *evaporation*, for indirect effects only. The former may be applied in an ice-bag, one-third filled with small pieces, or it may be used to cool water which is then circulated in Leiter's tubes, or dripped by irrigation over the part, or, if more convenient, a cloth may be wrung out of it

and laid over the part. Should cold injections be required, the ice may be put in the water or lotion.

The great physical fact, that evaporation requires heat, and that fluids will abstract the heat they want from surrounding parts, in order to evaporate, is often turned to account when a low temperature is wanted—*e.g.*, a wet cloth laid over the skin, and allowed to evaporate, will chill the part it lies on, hence the risk of wet clothes. If fluids which evaporate more quickly than water be used, the cold will be so much the greater; hence the use of alcohol and solutions of carbonate of ammonia in evaporating lotions (see *Appendix*). One of the most volatile of available fluids is ether. When the evaporation of this is hastened by a blast of air, the freezing-point is easily reached.

Cold, as a hæmostatic, is chiefly recommended for hæmorrhage in internal organs at some distance below the surface—such as in suspected hæmorrhage from the brain. The cold must be so applied as to affect the constriction of the vessels of the affected part, or that of the main vessels leading to it. Its application should be continuous, so long as it does not lower vitality to any appreciable extent; hence the need of care in its use.

Formerly, cold injections were used for bleeding mucous membranes and for deep oozing wounds; but where a fluid at a temperature of about 110° F. can be brought to bear upon them, we should advocate its use instead.

Application of Styptics.—Out of the many styptic agents which have been employed, it is only necessary for us to explain the use of a few. No matter what the styptic is, it should always be applied directly to the mouths of the cut vessels, without any intervening blood or blood-clot. Thus, when an operation has been performed upon a part in which the circulation can be controlled by a tourniquet, if a styptic is to be used, it should be applied before the tourniquet is relaxed in order that its full effect may be obtained. Of course, we may wish to apply styptics while bleeding is still going on; then we must do our best to first sponge the surface clean and remove all the clots which have collected in the wound. A styptic, when mixed with blood on the surface of a wound, only makes a cloggy mass, which, while not stopping the bleeding point, hides it from subsequent attempts.

Various Styptics.—Powdered alum and matico leaves are recommended as styptics, but are not often used.

(*a*) *Adrenalin.*—By far the most efficient agent is adrenalin, or other similar preparation of the active principle of the supra-renal gland. It acts by causing constriction of the smaller vessels. The drug is sold in solution, or in a dry form suitable for solution.

(*b*) *Turpentine,* soaked in a cloth which plugs a deep oozing wound, acts well. This may be called a domestic remedy, and is an antiseptic as well as a styptic. It is less irritating to the tissues than perchloride of iron. Some hold that the plugs in which it is soaked should be

removed at the end of a few hours; but it is doubtful if any further irritating effect is produced after this time.

(*c*) *Tincture of Perchloride of Iron* is one of the most efficient styptics in use, but it is, at the same time, one of the most irritating to the tissues, and its application is generally followed by more or less sloughing. It makes a hard sticky mixture with blood-clot, of a dark colour, and unless applied, as above stated, directly to the raw surface, it does more harm than good. It should only be used when unavoidable. It may be painted on the wound surface, soaked in the texture of a plug, or, after dilution, injected into a cavity.

(*d*) *Hazeline*, or the active principle of Witch Hazel (*Hamamelis virginica*), has during the last few years been found useful as an astringent and hæmostatic. Locally, it may be applied as an ointment, or in solution, by injection, painting, or on a plug.

(*e*) *Tannic Acid*, applied as powder or in solution, has long been advocated as a local and remote styptic, as well as an astringent. When applied locally, tannic acid precipitates albumin and may thus be of service for discharging surfaces, but other agents are preferable for primary hæmorrhages. "As a remote astringent it is valueless" (*Stockman*).

In addition to the above, most of the antiseptic agents in common use, such as solutions of carbolic acid, corrosive sublimate, chloride of zinc, tend to check capillary oozing in proportion to their strength, aided also by the temperature at which they are applied. Peroxide of hydrogen also enjoys some repute.

(*f*) *Caustic Agents*, especially strong acids, act also as styptics by coagulating the blood and attacking the mouths of the vessels. Of these, nitrate of silver may be selected to stop the bleeding from leech bites, and strong nitric acid is useful for the bleeding which comes from sloughing phagedæna, as it checks the disease as well as the bleeding.

(*g*) A hot saturated solution of calcium chloride should be tried. This salt greatly hastens coagulation of the blood, both when mingled with blood and when given internally.

Other Means.—Besides local applications, other ways of inducing arrest of hæmorrhage are available. The general circulation can be kept quiet by the horizontal position, low diet, abstinence from stimulants or hot fluids, which excite the heart, and freedom from mental excitement; functional rest can be aimed at for the affected part, and *certain drugs* can be administered, which experience has proved to be of service. Ergot, given by the mouth, or injected subcutaneously, seems to act on the vessels of other organs besides those of the uterus, probably by causing spasm of the muscular walls of small arteries. Turpentine, in 3 min. doses, given with mucilage, and repeated every two hours, is certainly of service in bleeding from the lung in phthisis. It might, therefore, be expected to be of use in wounds of the lung, and probably in other forms of internal hæmorrhage as well. Tincture of hazeline in 5 to 10 min. doses is also strongly recommended. Wright has drawn attention to the value of calcium chloride in hastening coagulation of the blood, and so acting as a

hæmostatic. He gives the drug in 15 grain doses, repeated twice or thrice a day. If this dose is kept up, the coagulation, which reaches its maximum of rapidity on the first day, is slower on the second day, and afterwards sinks below the normal rate. Hence two or three doses of the drug will probably be sufficient. He finds it acts very well in hæmophilia in hastening coagulation, and it has proved of much service in bleeding from the lung, kidney, and nose. Its value in cholæmia is doubtful.

Other observers have not been able to confirm Wright's experience with calcium chloride. Many prefer a subcutaneous injection of horse serum to anything else. Anti-diphtheritic serum does very well—the fresher the better.

B. **Secondary Hæmorrhage** differs practically from Primary Hæmorrhage in this, that the bleeding comes from vessels whose mouths are softened by granulation, and are therefore incapable of holding a ligature, the surface of the wound being also obscured by granulations so that the individual textures cannot be distinguished. This bleeding is almost invariably from a septic and suppurating wound, and may set in at any period while the suppuration is going on. When silk ligatures were used in septic wounds, secondary hæmorrhage was most common at the separation of the ligature about the third or fourth day; but it might appear at any time, if the ulceration extended to the coats of any large vessel. The worst feature of secondary hæmorrhage is—the uncertainty of its onset. It often comes on while the patient is asleep, without disturbing him in the least, often while he is improving in health, and when the wound, except for a slight suppuration, seems rapidly healing. On this account, wounds suppurating near large vessels (especially if recently ligatured), must be watched with the greatest care. No foreign body should be allowed to press upon the wall of a large vessel, especially not on an artery. The effect of the resistance of the blood within the vessel and the pressure, however gentle, of the foreign body outside of it, is nearly certain to lead to ulceration through the coats. On no account, for instance, should a drainage-tube be allowed to press upon the sheath of a large artery. Lives and limbs have often been lost by the faulty position of a drainage-tube.

As soon as secondary hæmorrhage is discovered, check it by pressure, if possible, upon the main artery leading to the part. Next, after assistance has been called, find out by the colour of the blood and nature of its flow, if it seem arterial or venous—remembering, however, that often in secondary hæmorrhage the flow from an artery is continuous, and not intermittent, since the blood may escape from a small hole, and flow through blood-clots and granulations. Often when the first compression is released, the bleeding has ceased—only to return, however, in a few days or hours, when the circulation has improved and the ulceration again made way.

Should the bleeding have ceased when the means of stopping it are at hand, precaution against its return should be adopted. The

circulation in the part must be diminished by posture, and functional rest; deep clots should be left undisturbed, superficial ones removed; the wound may be cleansed with antiseptic lotions, and a pad placed over the bleeding spot. In a limb, a tourniquet may be left loosely in place, and special watch be kept against the risk of fresh bleeding, while at the same time the general indications as above are carried out.

Should bleeding break out at any time in a smart stream and resist moderate pressure, elevation of the limb, and rest, an effort should be made to detect its source. If from a large artery, and if graduated pressure with styptics fail or seem inadvisable, the only resources are ligature of the main trunk higher up or amputation. If it be from a large vein, localised pressure is generally sufficient, aided by styptics, and by the removal of all obstacles to the venous return.

If the bleeding should be in the form of a general capillary ooze, the limb must be raised, and the part injected with a hot antiseptic lotion, or swabbed out with adrenalin solution (1 to 1000), turpentine, hazeline, or chloride of calcium solution, after which a dressing with firm pressure should be applied, and the general circulation kept down. Plugging is not generally required.

C. **Reactionary Hæmorrhage** occurs a few hours after a recent wound, on the return of strong blood pressure after a condition of shock. Blood-clots are pushed from the mouths of vessels, but remain in the wound as a kind of poultice, which encourages vascular dilation. To check this form of bleeding, the wound should be exposed, and the amount of bleeding noted. Sometimes cold or hot antiseptic injections will suffice. If not, the wound must be opened up, and the clots removed. Should this fail, the bleeding point or points must be found, and secured with a ligature. Where no single point can be seen, and if the above measures have failed, reactionary oozing must be treated like secondary capillary oozing. General oozing may be expected in hæmophilic patients, and in parts congested either from previous inflammation or from undue prolongation of the "bloodless" method.

CHAPTER VII.

ARREST OF HÆMORRHAGE (*Continued*).

Contents.—Treatment of Bleeding from Special Parts.—Bone; Fibrous Textures; Deep Cavities—From the Nose; Rectum; after Lithotomy; from the Prostate; Varicose Veins; the Bladder; the Kidney; the Mouth; the Tonsil; the Palmar Arch—Hæmophilia—Digital Compression of the Main Arteries—**Transfusion**—Of Water or Saline Solution; of Blood.

Bleeding from Special Parts.

THE various rules which are given for stopping bleeding after particular operations, are based—not on any difference in the processes of healing of vessels in different parts—but upon the differences in their position, and therefore in their accessibility, in the nature of the surrounding tissues, and in the functions of the part in which they lie. As a general rule, when there are no large vessels involved, the use of sterile gauze compresses soaked in adrenalin may be commended.

(*a*) *Bleeding from bone* may be troublesome, because the vessels have less muscle than usual in their walls, and, besides, cannot easily contract on account of their hard surroundings. Moreover, the hard, dense surrounding bone prevents the application of a ligature. If the vessel be a fairly large one, such as the inferior dental, a sterilised wooden plug should be put into it for a few minutes. In most cases, firm plugging of a cavity is sufficient, and acts well, because the surrounding parts are so resistant. The best plug is a long narrow strip of lint or gauze impregnated with iodoform, bicyanide of mercury, or other antiseptic, tucked in upon itself into the cavity. The end or ends must be left out for convenience in withdrawing. It is not generally necessary to leave the plugs in for more than twenty-four hours. Horsley's paste (see *Appendix*) is often useful during operations.

(*b*) *Bleeding from firm fibrous textures* resembles that from bone. Such textures are the firm subcutaneous tissues of the scalp, or connective tissue in any other part of the body matted by chronic inflammation, or that found in a fibrous or fibroid tumour. Here also the mouths of the vessels remain open, and cannot easily be tied, but compression or plugging is effective if the region is accessible. If the bleeding vessel can be reached behind the *bleeding point*, it may be controlled by the pressure of the pad or compressed by an acupuncture needle, third method (p. 65). Styptics, and especially the actual cautery, may sometimes be applied to the bleeding point.

(*c*) In *bleeding from deep cavities*, besides hot (or cold) and astringent injections, the principle of *tamponing* may be carried out. This consists essentially in introducing a *rigid* tube to permit of drainage or maintain patency, and packing round about it. The simplest way to do this is to tie a piece of lint or oil-silk round the deep end of the tube to form a petticoat, and to distend this with plugs, as has long been practised for bleeding after lithotomy (Fig. 29). Another way is to adapt outside of the tube a distensible india-rubber bag, which can be inflated at will. On this principle depend Trendelenberg's tracheotomy tampon, Buckstone Brown's lithotomy tube, and similar devices suggested for the nostril and rectum. After these general remarks, a few directions may be necessary for special forms of hæmorrhage.

(1) *Bleeding from the nose*, or epistaxis, is sometimes extremely troublesome. The patient should stand erect—*not stoop*—bathe the face and neck with cold water, and sniff air gently through the affected nostril. Raising the arms above the head helps to lessen the circulation in the head and neck. Hot injections should next be tried, then swabbing out with adrenalin solution (1 to 1000) or some of the milder styptic colloids, plugging the anterior nares afterwards, then plugging also the posterior nares. If this fail, the cavity of the nostril may be packed with a long strip of lint, either soaked in some styptic or dry. We do not advise the injection of perchloride of iron, as it irritates the mucous membrane so much. Sometimes great benefit results from freely opening the bowels with a large enema or smart purge.

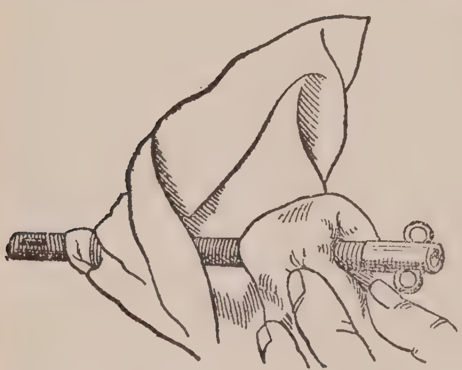


Fig. 29.—Lithotomy Tube, with Plugging.

To plug the posterior nares, pass a stout silk thread from the nostril round the soft palate and out at the mouth. To the centre of this, loop a pledget of lint, about the size of the last joint of the patient's thumb, and draw it by the nose-thread into the mouth ; work it past the soft palate, with the finger if necessary, and draw it into the posterior nares. The thread in the nose and that in the mouth are then to be tied together over a pad of lint to prevent the thread from cutting.

For passing the thread through the nostril, a Belloc's sound may be used ; but an equally good way is to make the silk fast to the end of a gum elastic catheter, which can be easily passed from the nostril into the pharynx ; when there either it or the thread may be drawn with forceps through the mouth. As soon as the silk is secured, the catheter may be withdrawn (Fig. 30).

In bad cases, the posterior plug may be left in position for twenty-four to thirty-six hours, then it should be carefully withdrawn by the thread left in the mouth.

(2) *Troublesome bleeding from the rectum* may occur from ulceration into varicose veins, or may follow the removal of internal piles. It may be either arterial, venous, or capillary, and is difficult to stop—chiefly because the sphincter prevents ready access to the bleeding point. Should the bleeding continue after the removal of clots and injection of hot water, apply cocaine and use a speculum. If the vessel can be seen, it may be stopped by the application of a strong styptic. Should this fail, give chloroform; stretch the sphincter, and pull down the affected mucous membrane; search for

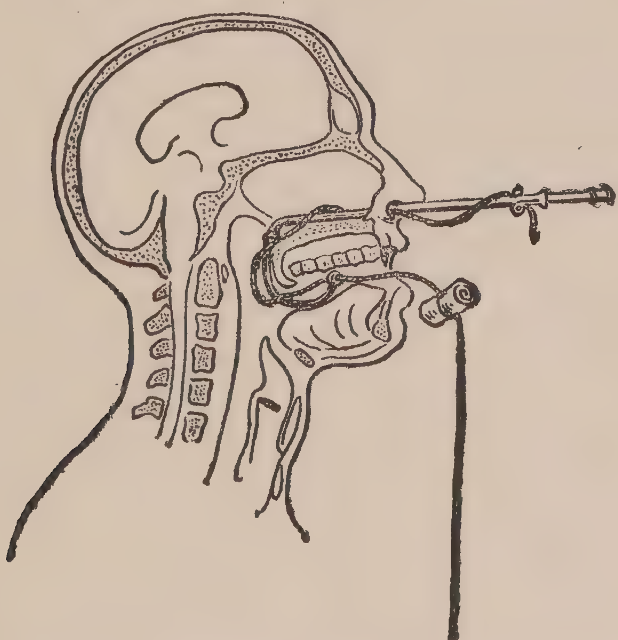


Fig. 30.—Belloc's Sound. Plugging the Posterior Nares.

the bleeding point and tie it. Digital pressure may be employed; this was kept up by Syme for several hours in a case where he had cut off an internal pile (before he had taken to the ligature). When surgeons used simply to cut off internal piles without further precaution, bleeding was common, and often fatal. Now bleeding is stopped by tying or crushing the base of the pile, or by cauterising the cut surface. When other means fail, the rectum may be plugged with a tampon, care being taken to avoid over-stretching of the sphincter.

(3) *Bleeding after Lithotomy* may be from the veins of the prostate or some perineal vessel, which, if visible, should be tied. If hot injections and raising the pelvis fail, use a tube and a petticoat, or Brown's tampon.

(4) *Bleeding from the Prostate* may come on in old men, apart from any operation. It is then probably from varicose veins. The bowels should be opened, and the patient kept recumbent with the pelvis raised. Calcium chloride may be administered internally (see p. 70), and a few drops of 1 to 1000 adrenalin solution instilled into the prostatic urethra, preferably through an acorn-headed catheter. When other means have failed, it may be necessary to drain the bladder.

(5) *Bleeding from Varicose Veins.*—Excessive hæmorrhage follows the rupture of varicose veins in the lower extremities. While the patient is erect, the flow of blood is backward from the heart. The enlarged veins are frequently buried in brawny, infiltrated, inflamed tissues, but sometimes traverse the base of an ulcer, which may be insignificant in size and appearance. It is in the latter case that danger is to be feared. Inflammation affecting the vein causes thrombosis, and so protects against hæmorrhage, but ulceration, which extends without a preceding area of inflammation is much more dangerous. When the wall of the vein gives way, a great gush of dark blood takes place. It ceases as soon as the patient lies down, and holds his leg vertically upwards. Even while he is erect comparatively slight pressure, if accurately applied, by means of a dossil of lint and a bandage, arrests the flow.

(6) *Bleeding from the Bladder*, when troublesome, is almost invariably from a tumour. No effectual cure can be expected short of removing the tumour, but the bleeding may sometimes be diminished by complete rest, internal styptics, and injections of such fluids as adrenalin solution, or hazeline. Sir H. Thomson advocated the injection of nitrate of silver, ·1 gr. to the ounce, gradually increased to 1 gr. to the ounce, or tincture of perchloride of iron, 30 min. to ℨi. to water ℥iv. Hazeline, ergot, or calcium chloride internally may be given at the same time.

(7) *Bleeding from the Kidney*, when extensive, may be the result of injury, or of an operation upon or near the kidney, or it may arise from a tumour. No direct application can, of course, be made to the kidney, unless there is an open wound. The patient must be kept at rest, and on milk-diet. Ergot, adrenalin, hazeline, or calcium chloride may be tried internally. The bowels must be kept relaxed to prevent irritation from hardened fæces. Pain is to be subdued by morphia. Sickness, when it threatens to appear, is avoided by simple and sparing diet. See also Chap. xxiv.

(8) *Bleeding from the Mouth* is commonly from the tongue, secondary to some operation. In an emergency, the lingual artery may be compressed, and at the same time brought forwards by the finger, passed back to the epiglottis, and then hooked forwards so as to bring the soft parts with it (*Heath*). If the wound be recent, the artery may be secured with forceps and tied; if not, the part must be plugged, with styptics, if need be. Should bleeding recur, the lingual artery may require to be tied—preferably behind the great cornu of the hyoid bone.

(9) *Bleeding from the Tonsil* sometimes occurs after tonsilotomy, and generally comes from an unusual or enlarged branch of the ascending pharyngeal artery. Whether the operation has been done with the tonsilotome or with the knife, if the abnormal artery be there, it will bleed when cut. From the position of the bleeding point, a ligature is very difficult to apply to it. Digital pressure maintained for some minutes, or the pressure of a hot sponge, may be enough. Should these measures fail, clear away all clots, and apply styptic pads, holding them in position for from five to ten minutes. If this fails, the bleeding point can be grasped with artery forceps, and they may be left in position for from six to twelve hours; or the bleeding point may be touched with the cautery. In a few cases, ligature of the common carotid has been required; but in spite of even this, death has sometimes ensued. Fortunately, however, the bleeding after tonsilotomy is generally slight, and ceases spontaneously in a few minutes It is worthy of note that in at least three recorded cases, previously serious bleeding ceased after a fit of vomiting, whether spontaneously or artificially induced.

(10) *Bleeding from the Palmar Arch* has been already alluded to. The reason for the difficulty is, that in the palm, the superficial arch is covered by strong fascia, and lies near large nerves. Free dissection is also prevented by the after-inconvenience of large cicatrices. The deep arch is out of reach. If a limited dissection give small hope of success, apply firm pressure—possibly graduated—with antiseptic precautions. At the same time restrain the circulation in the hands by the methods already indicated (p. 66). Should these measures fail, ligature of the brachial artery would be the next step.

Hæmophilia.—The above indications have been made on the assumption that the patient's tendency to spontaneous healing of vessels has been normal. There exists, however, a condition, fortunately rare, where patients bleed long and freely on the slightest provocation. The disease is known as "Hæmophilia," and the patients as "Hæmophilics" or "bleeders." The nature of the malady is obscure. The vessels seem normal, but the cause of the bleeding tendency seems to be an imperfect power of coagulation. Apparently the most efficient means of increasing the coagulability of the blood is by the subcutaneous injection of serum. Fresh human serum drawn from a blister in doses of 10 to 15 c.c. has been used with advantage, also horse serum in the form of anti-diphtheritic serum in the same quantity. Calcium chloride is also advocated by Wright (see p. 70). Swabbing the bleeding part with adrenalin solution (1 to 1000) should also be tried.

Hæmophilia is often hereditary, and is probably often present in degrees. In bad cases, a slight pinch of the skin will be followed by extensive ecchymosis, and smaller cuts by continuous oozing. In dealing with such patients, reliance must chiefly be placed upon pressure and styptics.

Digital Compression of the Main Arteries.

Common Carotid.—Against the vertebral column, by pressure directed backwards at the level of the sixth cervical transverse process—*i.e.*, about the level of the lower border of the cricoid cartilage.

Facial.—Against the lower jaw by backward and inward pressure in front of the anterior border of the masseter muscle. To be of any service, both ought to be simultaneously compressed, owing to the free anastomosis round the mouth, etc.

Temporal.—Pressure directed inwards just in front of the external auditory meatus.

Occipital.—Pressure against the occipital bone midway between the mastoid process and the external occipital protuberance.

Subclavian (*third part*).—Against the first rib by pressure downwards and backwards, just behind the anterior curve of the clavicle.

Axillary (*third part*).—Against the humerus by pressure directly outwards, at junction of anterior and middle thirds of the axilla.

Brachial.—Against the humerus. The pressure must be outwards at the upper part. outwards and backwards about the middle, and backwards at the bend of the elbow, to suit the altering relations of the bone and artery. The artery continues the line of the axillary to the middle of the bend of the elbow.

Radial and Ulnar Arteries.—At the wrist, pressure backwards at either side.

Abdominal Aorta (see p. 57).

External Iliac.—By pressure directly backwards against the brim of the pelvis, midway between the symphysis pubis and the anterior superior iliac spine.

Femoral.—Pressure must be made at first backwards against the head of the femur, then backwards and outwards in Scarpa's triangle —in Hunter's canal, outwards. When viewed from the inside—*i.e.*, in abduction—the line of the vessel continues that of the external iliac towards the adductor tubercle on the inner condyle of the femur : looked at from the front, the line runs towards the inner edge of the patella. The first point mentioned for pressure is the best (see chapter on *Extempore Appliances*).

Anterior Tibial.—Midway between the two malleoli, backwards against the tibia.

Dorsal Artery of the Foot.—Downward pressure against the tarsus between the mid-point of the malleoli and the interval between the first and second metatarsal bones.

Posterior Tibial.—Forward and outward pressure against the tibia, a thumb's-breadth internal to the inner malleolus.

Transfusion.

The methods of injecting fluid directly into the veins of persons who are greatly reduced by loss of blood or wasting disease, have been, in recent times, revived and much discussed. The objects to

be attained by such proceeding are these: either (1) to add fluid to the circulation, and so give the heart something on which to contract; thus to enable it to utilise the blood which always remains in the veins after bleeding, and to stimulate absorption (water or saline fluids); (2) to add also nutriment to the blood; or (3) to add to it, besides fluid and nutriment, red blood-corpuscles, which will be functionally active as respiratory agents (blood).

Of these, while the second is of doubtful value, and the third requires a delicate and different technique, the first is unquestionably possible, and is often all that is required to save life, especially after sudden hæmorrhage. The effect produced has been called the "*dynamic*" effect. Aseptic (boiled) water at blood-heat, injected to the amount of about 1½ litres (2¾ pints), has been found sufficient in an apparently desperate case of post partum hæmorrhage. A warm ¾ per cent. solution of common salt in boiled distilled water (about a drachm to the pint) would be preferable to plain boiled tap water. Various other saline solutions have also been recommended, but it would be difficult to prove their practical advantage over a ¾ per cent. solution of common salt. Where the patient's system is depressed from want of food from any cause, 5 per cent. of glucose has been added, by Lennander, to the normal saline solution with apparent advantage.

Apparatus Needed for Saline Infusion.—A nozzle of glass or metal, for tying into the vein, and a piece of tubing to attach it to a small glass funnel raised 2 feet above the opened vein. Some prefer a syringe. The end of the nozzle, if cut obliquely, will enter the opening in the receiver's vein more easily. A metal nozzle, with bulbous end, is strongly to be recommended.

Mode of Procedure.—*In Infusion of Water or Saline Solution.*—First retard the circulation in the limb so that the veins may be distended and a suitable vein selected. The median basilic vein is generally chosen, but it may be irregular in size or position. Inject a local anæsthetic (see p. 27), or freeze the site of the incision (p. 29). Then expose with scalpel and forceps the vein selected. Pass a double catgut ligature under it. Tie the distal one to prevent bleeding. Now fill with saline fluid at a temperature about 100° F. the previously sterilised and warm funnel, to which the similarly prepared nozzle has been attached. Clamp the tube near the nozzle to ensure that it keeps full of fluid, and entrust it to an assistant. Nip up with forceps a piece of the coat of the vein, and incise it with knife or scissors. Enter the nozzle and secure it in the vein with a single twist of the proximal ligature. Before releasing the clamp compress the vein just beyond the nozzle. Now release the clamp and shake the apparatus while holding the funnel vertically. If air has got into the nozzle it will ascend. Should a syringe have been used the piston should be slightly drawn back before the fluid is injected. This withdraws any air that may have got in. Having now excluded air, release the pressure on the vein and allow the fluid to enter. *N.B.*—After the injection is finished, the nozzle is withdrawn and

the proximal ligature tightened. If a repetition of the injection is anticipated, the ends of this ligature should be left long for use again. Otherwise, the ends are to be cut short. The wound is dressed with a small pad of sterilised gauze and a bandage.

Munchmeyer's method is both simple and efficient. The needle of an aspirator is thrust into the subcutaneous tissue between the scapulæ, under the mammæ, or in the groin. To the needle is attached 2 or 3 feet of the india-rubber tubing leading down from a funnel. The saline fluid (1 to 3 pints) is poured into the funnel and is dispersed in the cellular tissue by gentle massage.

All the instruments used should be boiled, or first cleansed with an antiseptic and afterwards washed out with boiled water.

Advantage may be taken of the rapid absorption of fluid which takes place in the rectum. The rectum having been cleared, from 4 to 6 or 8 ozs. of the fluid should be injected slowly, and repeated every hour or two. Enemata of warm saline fluid will in many cases serve all the purposes of infusion into a vein or into the cellular tissue.

After operations for acute peritonitis from perforation, Murphy's method (proctoclysis) has given good results. An ordinary vaginal tube introduced just within the internal sphincter is connected by rubber tubing, without any constriction interposed, with a vessel containing warm normal saline solution, which runs in and is absorbed at the rate of about 1 pint per hour. The pressure of the column of water should be slight (4 to 6 inches). Absorption is continuous and gradual. The low pressure and the absence of constriction in the tube, allow of the fluid being returned into the vessel should the bowel contract. The patient should be supported in bed reclining in the half-sitting posture in order to favour gravitation of fluids from the regions most prone to septic absorption towards the less susceptible pouch of Douglas (see p. 11).

No mention has been made of drinking to introduce fluid into the system, but this method will of course be used when available. The rectal method would come next in preference, then infusion into the cellular tissue, and lastly infusion into a vein. The latter is the most rapid method, but there is no gauge as to when to stop. If too much be poured in, it may be excreted again in regions such as the lungs where it will do harm.

Direct Transfusion of Blood.—See Appendix A., p. 312

CHAPTER VIII.

SHOCK AND WOUND-FEVER.

Contents.—Shock—Symptoms and Treatment—Syncope—Wound-Fever—Pulse and Temperature Indications—Treatment—Inflammation—Treatment by Antiseptic Poultices, by Blood-letting and by Counter-irritation.

Shock.—Whatever be the cause of the condition—*e.g.*, extensive crushing of a limb, or especially of the abdominal viscera, severe burn, loss of blood, great pain, or extensive operation—the symptoms and treatment are similar.

The **Symptoms** are pallor and moisture of the skin—feeble, fluttering pulse—soft shallow breathing, and great langour.

Cause of the Symptoms.—Among much that is doubtful as to the pathology of shock, there is a growing acceptance of the view that in shock the fluid part of the blood escapes from the vessels, probably into the cellular tissue, and that the arteries contract upon the diminishing volume of blood as if to maintain the blood pressure; further, that the vaso-motor centres are not paralysed until death is imminent. The heart is impeded from want of fluid to contract upon. Malcolm, who has maintained this view for many years, has never observed dilatation of the splanchnic veins in cases of shock during abdominal operations.

One factor in the feeble respiration seems to be an insufficiency of carbonic acid to act as a stimulus to the centre (*Yandell Henderson,* acapnia theory).

The **Treatment** may be summed up briefly as follows :—

(1) *Relief* of immediately severe *pain* by hypodermic injection of morphia, and removal of any obvious cause of suffering.

(2) Zealous supply of *external warmth* by hot bottles, hot plates, and blankets—also administration of hot tea or coffee, Liebig's extract, or gruel. (See also electric hot-air bath in *Appendix.*)

(3) Improvement of the cerebral circulation, and hastened return of blood to the heart from the abdominal veins by raising the foot of the patient's bed 12 to 18 inches.

(4) Concentration of the blood in circulation to vital parts by bandaging the limbs firmly from the extremities towards the trunk. This procedure may be adopted in shock from any cause, but is specially useful where there has been loss of blood. It may be carried out while preparations for saline infusion are being made. The bandages should be removed after a few hours at longest. The abdomen may be supported by a binder or broad bandage at the same time.

(5) In severe shock, even when there has been little or no loss of blood, injection of normal saline fluid into the rectum, cellular tissue, or into a vein is of the greatest value (see p. 78).

(6) *As to stimulants*, in very severe cases of shock, it is now considered better to *omit* altogether alcohol, strychnine, and ether, as by their after-effects they seem to do more harm than good.

Syncope, or fainting, is treated by increasing the cerebral circulation, and stimulating the sensory nerves. In many cases, if the patient be sitting when faintness comes on, much benefit will be derived from bending the trunk and forcing the head well down between the knees. After fainting has occurred, the patient should be laid flat on the back, and all tight clothing on the chest or abdomen relaxed. The face may be slapped with wet towels, and the nostrils stimulated with ammonia vapour. A stimulant of wine, spirits, ether, or sal-volatile may be given as soon as the patient is able to swallow.

Wound-Fever.—(*a*) **Pulse-Indications.**—In regard to the pulse-records, it may be noted that to surgeons the frequency is of the highest importance, and a continuously rapid pulse may give warning of evil long before the temperature signals danger. Besides frequency, rhythm is also to be noted. A pulse over 120, with variable regularity, always gives rise to anxiety. Previous to operation, there should be a careful examination made of the state of the circulation. The force of the heart's action, as modifying the choice of an operation or anæsthetic; the condition of the pulse, as indicating the presence of atheroma; aortic regurgitation and the tension associated with kidney-disease are also well worthy of study. Slowing of the pulse is characteristic of cerebral compression.

(*b*) **Temperature-Indications.**—Rise of temperature is a condition seen in fever and inflammations. Since the temperature is not so likely to be influenced by emotional and slight causes as the pulse, it furnishes more reliable data; but there are certain dangerous conditions, which are often *not* characterised by a rise of temperature. Thus we find that some rapid and violent septic poisonings, peritonitis, empyema, and also cerebral abscess may exist without it. Again, very high temperatures have been recorded as the result of injuries in special regions—as, for example, in fracture of the cervical spine (110° F.), hæmorrhage into the Pons and Medulla, and in some cases of cranial tumour. These, however, are altogether peculiar, and may have relations to heat-centres, more especially since very low temperatures (85° F.) have also been observed in connection with some spinal and cranial lesions. On the second and third day after most injuries, even although subcutaneous or aseptic (as, for example, simple fracture), a rise of one or two degrees often takes place, and the same phenomenon attends on aseptic wounds. This, then, gives no cause for anxiety. It may be due to some waste product circulating in the blood; but we are in the dark as to its precise origin. A very different rise follows the advent of sepsis. This shows itself generally by a marked and increasing rise of temperature,

which, however, gradually falls as granulation advances, and the wound no longer absorbs. Where abscess forms, rigors may take place with marked rise. If constitutional blood-poisoning develops, the temperature may vary from the regular nocturnal increase of hectic to the more erratic jumps and relapses of pyæmia. When tension is associated with pain, as in whitlow and orchitis, increased heat is also present, and this abates at once on removal of tension.

A rise of temperature is of graver import in the aged than in adults, and in adults than in children. Where 104° is reached the prognosis is always guarded, if the temperature does not speedily yield to treatment. The conditions of shock and loss of blood always give rise to low temperature. The advent of erysipelas is often indicated by a rise of temperature before other symptoms have appeared.

Treatment.—We may look upon the most serious accelerations of pulse and temperature in surgical cases as generally due to wound-fever—*i.e.*, a true septic absorption—and therefore preventible. The *treatment* where this fever occurs, then, is—not so much to lower the temperature by the administration of drugs as—to strengthen the patient, and enable him to combat the poison he has absorbed, and to prevent the entrance of more. Nourishing food, and often diaphoretics are therefore desirable, until the purification and free drainage of wounds amend the local condition. When wounds have become distinctly septic, and general blood-poisoning ensues, the best treatment is to remove all the stitches, and purify the wound-surface, and, where possible, use passive congestion (see p. 49). In some cases, the part may even be removed entirely, as, for example, in pyæmia or septic gangrene, where amputation may save the patient's life. Irrigation, free drainage, and pure air are necessary. The rise of temperature due to local tension and pain may subside under the influence of moist warmth, or an antiseptic poultice. If the condition persists, free incision is indicated, as soon as pus has formed. The urethra and bladder often exhibit most interesting phenomena in regard to rigors and fever in their reaction to instrumentation. A great rise and rigor often follows the passage of a catheter in some individuals. This is obviously nervous in origin, and may be antagonised by the use of novocain and morphia. Again, there may be no trouble till the patient makes water. This is sometimes followed by a rise due to the absorption of some alkaloid from the urine. Finally, the urine itself may become infected from a dirty instrument, and from this a true catheter-fever, septic in character, due to absorption, may follow.

Where other means have been ineffectual, general and local remedies are required. We may attack the fever by specifics such as quinine, antipyrin, and the like, or act on the skin and circulation, and so cause lowering of the temperature. The most energetic mode of cooling the patient is by means of Leiter's iced-water coil. This method is also applicable as a local antiphlogistic in inflammation of joints, etc. When there is a rise of temperature *with a scanty secretion of urine* (as, for example, after operations on the urinary tract), the

hot "pack" is indicated. This is readily carried out by rolling the patient in a blanket, after placing around him hot bottles enveloped with moist warm flannel or stockings.

Inflammations, which threaten to form abscesses, often yield to *antiseptic poultices*. These are made by enveloping the part in boric lint, soaked in carbolic lotion, and covered with mackintosh or gutta-percha. Local blood-letting is often serviceable.

This treatment is most suitable for those inflammations in which the affected area is small and the process not very virulent. In severe and spreading forms of inflammation—cellulitis, as it is often called—free incisions should be made into the inflamed area even before pus has formed, and still more without delay if pus is present when the case is first seen. (See also pp. 48-49.)

Blood-letting by leeches, or otherwise, is not often employed now, but may be useful in acute inflammations.

(1) *By Leeches.*—Leeches are to be applied as follows:—The part of the skin selected is washed and, if hairy, shaved; it is then dabbed over with milk. The leech or leeches are then taken from the box in which they are usually sent up, and allowed to swim for a few minutes in a basin of clean water. Each, before being applied, should next be allowed to crawl over a clean towel for a few minutes. It is then to be taken up in a wine-glass, or test-tube, which, when inverted, is placed over the desired spot. Considerable patience is often expended before the leech can be induced to fasten; when it has once taken hold, it may be left till it becomes distended, and drops off.

Leeches to mucous surfaces (as of the vagina), must be applied in carefully adjusted test-tubes, or in leeching glasses—*i.e.*, tubes open at one end, and at the other end narrowed so as to allow the head only of the leech to protrude.

When much blood has to be removed, the leech-bite should be fomented with warm water.

When the bleeding continues too long, pressure with a pad will generally stop it; but if this fail. the leech-bite should be touched with a point of solid nitrate of silver.

The continuance of the flow is due to the anti-coagulating substance secreted from the leech's pharynx (*Haycraft*).

(2) *By Cupping*, which is of two varieties. In dry cupping, the blood only is drawn to the surface; in wet cupping, it is withdrawn from the body.

(*a*) For *dry* cupping, Dr. Klapp's cupping glasses are the most convenient, but an empty jam pot, cup, or strong tumbler will suffice. A flat surface of skin should be chosen; this should be wetted. The interior of the cupping glass should then be well heated (to expel the air), either by holding it over a spirit lamp, or by throwing a piece of lighted paper into it. In the latter case, the paper should be extinguished by clapping the glass against the skin; in the former case the glass should be withdrawn from the flame, and immediately pressed into its place on the skin. A vacuum is produced inside the glass, and the skin, deeply congested, rises up into it.

(*b*) For *wet* cupping, a set of cupping knives are needed; these consist of 10 or 12 sharp blades, working in a half circle through slits in a metal plate fixed to a frame. The distance to which the

blades project beyond the plate can be regulated by a screw. The blades are first brought through their course against a spring, and are held there by a catch, "full cock." When a button is pressed, they spring back at once, sweeping over the slits to the depth already regulated, and, of course, make corresponding cuts in whatever comes in their way. The depth of the wound must vary with the patient's skin. It should be just through the skin, but not into the subcutaneous fat, lest pellets of fat should block the cuts, and stop the needed bleeding.

Having adjusted the depth of the knives, and having placed the instrument at "full cock," the surgeon first dry-cups the desired place; then pressing the brass plate against the skin, he discharges the knife-blades, and immediately applies the exhausted cupping glass again, which will now rapidly fill with blood. It must be emptied, and re-applied as often as required. The wound, after having been cleaned, should be dressed with dry boracic lint, or absorbent wool.

A simple form of artificial leech can be extemporised by using a test-tube as an exhauster after having scratched the skin with a bistoury.

(3) *By Venesection.*—This may be practised from the median basilic vein. A fillet is placed on the upper arm, to retard venous return, and an oblique puncture is then to be made through the skin

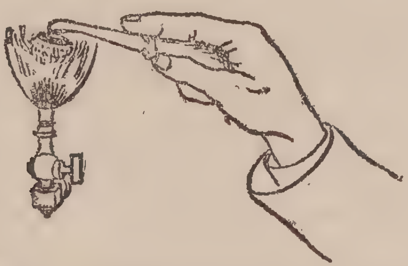


Fig. 31.—Heating the Button Cautery.

into the vein, with a sharp pointed bistoury, or lancet. Blood will now flow freely. If it becomes sluggish, the patient should work the hand and fingers vigorously. From 8 to 20 ozs may be withdrawn at a sitting.

In special cases, any distended vein may be selected.

A dry pad fixed over the wounded vein is all that is needed to stop the blood. after the fillet has been removed.

Counter-irritation may be applied by blisters by cautery, or by other means.

(1) *By Blisters*—A fly-blister of the desired size is applied to the skin, and left on for six to eight hours; or blistering-fluid is painted on the part until it becomes white. The blister which rises is then snipped, and the raw part dressed with zinc ointment, oil-silk or wet boracic lint.

(2) *By Cautery*—(*α*) *The Button Cautery.*—This is heated in the gas or spirit lamp, as indicated in Fig. 31, until the forefinger feels uncomfortable and is then rapidly tapped over the skin at various places, so as to leave a reddened spot behind it each time. (*β*) When the actual cautery is applied, a red-hot iron, or the *thermo-cautery*, is needed, and an anæsthetic is indicated. The skin should be first cleansed. The burn ought *not* to destroy the whole depth of the

epithelium; if the seared part be at once covered with collodion, no further dressing will be needed.

When it is desired to prolong the action of any counter-irritant, the raw surface should be dressed with sabine ointment, which irritates it, and keeps it open.

(3) *By Potential Caustics* (see *Appendix*).

(4) *By Croton Oil*, which, when rubbed into the skin, is a powerful counter-irritant, and causes a smart pustular eruption.

Tincture of Iodine is a mild counter-irritant. The liniment of iodine is much stronger.

CHAPTER IX.

EMERGENCY CASES.

Contents.—A. Treatment of Surgical Emergency Cases—(1) Retention of Urine from Stricture of Urethra; Enlarged Prostate; Spasm of Constrictor; Acute Inflammation of the Prostate; Urethral Calculus—(2) Possible Rupture of the Urethra—(3) Possible Rupture of the Bladder—(4) Possible Injury of the Intestines—(5) Strangulated Hernia—(6) Severe Compound Fractures and Dislocations—(7) Injuries to the Eye—(8) Lodgment of Needles under the Skin—(9) Foreign Body in the Nostril—(10) in the Ear—(11) Obstruction to Respiration (from Swelling of the Fauces; Croup, or Diphtheria; Foreign Body in the Air-passages, Pharynx, or Œsophagus—*Artificial Respiration*—(12) Treatment of the Apparently Drowned—(13) Severe Head Injuries—(14) Cut-throat.

UNDER the category of "emergency" cases—cases in which prompt and decided action is necessary—come both Surgical Cases (strictly so-called), and Cases of Poisoning

A. Surgical Emergency Cases.

In the prognosis of surgical cases, as of others, we have to consider remote as well as immediate dangers. The latter draw attention to themselves, but the former, only appreciated by experience, are apt to be unheeded until the time for their possible remedy has gone. Under the head of "emergency" cases we wish, therefore, to allude briefly to the diagnosis and treatment of cases involving both classes of danger.

(1) **Retention of Urine**, almost invariably found in men. If recent, causes great pain and feeling of distention, and demands relief by the patient's symptoms no less than by the dangers which threaten him. After a time, however, the spasms subside, while the bladder goes on dilating. In some cases, the obstruction may by this time have subsided, and then the chief symptom will be that of constant dribbling from an over distended and almost completely paralysed bladder.

If unrelieved, the pressure, aided by ulceration behind a stricture, may cause a rupture of the urethra, and extravasation of urine into the perinæum, or, with only a slight blow on the abdomen, a still more serious pelvic, or abdominal extravasation from a rupture of the bladder. Sometimes suppression of urine, and uræmic poisoning may occur, from a backward pressure upon the kidneys, or there may be a long standing after-paralysis of the bladder.

The *cause of the retention* may be anything that obstructs the canal of the urethra—whether stricture, enlargement of the prostate, inflammation or abscess of the body of the penis, urethral calculus, or spasm of the constrictor. (Retention due to primary paralysis of the bladder is a serious symptom of a more extensive paralysis.)

The diagnosis of the retention is made by percussion and palpation, taken together with the previous history. The diagnosis of the cause of the retention will vary with the conditions which produce it, thus :—

(*a*) *Retention from Stricture of the Urethra.*—Here we have generally the history of a gradually diminishing stream with painful and frequent micturition, following sooner or later after gonorrhœa or an injury to the perinæum ; exposure to cold, or a bout of drinking, may determine the complete obstruction. By passing the finger gently along the urethra from the outside, the amount of callous thickening in and around the tube can be recognised.

When an urgent case of stricture is brought to hospital, the patient should have a ¼ or ½ gr. morphia suppository, and should be made to sit in a warm hip-bath. While sitting in the bath he may sometimes be able to pass water. If this fails he should be put to bed before any effort is made to draw off the water.

Treatment.—Having gently ascertained the amount of bladder distention, the house-surgeon, after cleansing the meatus and glans penis with an antiseptic lotion, may begin by applying novocain and adrenalin to the seat of stricture. About 40 minims of 3 to 5 per cent. solution of Novocain (*i.e.*, 3 to 5 grains to 110 minims) to which a few drops of adrenalin solution have been added may be injected through a catheter down to the stricture, or the solution may be applied with cotton wool on a probe. The solution takes from five to ten minutes to act. He then disinfects a medium-sized catheter by syringing with 1 to 20 carbolic acid, or with boiling water if it be metal; and after it has been warmed and lubricated (see *Appendix*, p. 324), passes it along the urethra to explore its condition and find the seat of stricture. In most cases this will be just in front of the triangular ligament, but there may be several strictures. Next, a soft instrument, either india-rubber or one of the French black probe-pointed kinds, is to be taken, and an effort made to pass it. Successively smaller numbers must be tried, and should the smallest fail, metal catheters must be used. The instrument should be warmed by friction with a towel or in hot water, and should then be well lubricated. The operator stands on the left side of the bed on which the patient lies, and gently lifting the penis with his left hand,

introduces the catheter into the meatus with his right. Supposing the stricture to be in the common place just in front of the triangular ligament, the operator steadily passes the catheter back to the seat of stricture. Some do this with the handle of the catheter in the mesial plane, while others keep the handle pointing towards the patient's left. So long as the *point* of the instrument is directed backwards along the urethra, either method is good. The second is easier, and is generally preferred. The difficulty begins at the place where the urethra changes its direction to reach the opening in the triangular ligament, and continues from that point till the instrument has fairly entered the prostatic urethra. In trying to pass the catheter at the point of difficulty, the surgeon must keep the point of the instrument exactly in the mesial plane. To ensure this, care must be taken that the patient's pelvis is not tilted, and that the handle of the catheter is in the mesial plane. On no account should the handle of the catheter be directly pressed upon, as this will drive the point through the floor of the urethra. The movement is rather a combined one of lifting the instrument upwards, while, at the same time, canting the handle backwards and downwards towards the patient's feet. By this manœuvre the point of the instrument is made to follow the curve which the urethra takes below the pubes. The surgeon feels cautiously for the orifice of the stricture at various parts of the obstructed portion of the urethra, and as soon as he thinks he has found it he tries to pass it through in the manner just described. A feeling of pain to the patient, and of the instrument being grasped by the stricture to the surgeon, are useful indications. Where there is much difficulty, the surgeon should insert his left forefinger—well oiled—into the patient's rectum to help in guiding the point through the membranous urethra. Should the instrument have left the urethra (false passage) the point will be felt to pass between the prostate and the rectum. By the time the point of the catheter has reached the prostatic urethra, the handle will be nearly horizontal, and when it has reached this position it should be gently pressed onwards into the bladder. In proportion as greater command is obtained with rigid instruments, so is there greater risk of their doing harm, especially when of small size. Until the feeling of being grasped is perceptible, the greatest gentleness must be employed, lest the urethra, anterior to the stricture, should be perforated and a false passage made. Any attempt at withdrawal will be resisted by the grasp of the stricture, and the operator may then have more confidence in gently pushing the instrument on. After great difficulty has been met with in passing an instrument, it is often well to tie it in for six or eight hours, or at once perform external urethrotomy.

When the smallest instruments have been tried in vain, and if the symptoms are not very urgent, the patient may be again put into a warm hip or general bath. The urethral injection of novocain and adrenalin may also be repeated. He may then be able to pass urine himself, or the next attempt with the catheter may be successful. If, however, the symptoms are urgent, an effort to pass a catheter under

chloroform should be made, and, if unsuccessful, the bladder should be aspirated just above the pubes. If cystitis has been present aspiration may cause cellulitis in the track of the needle, but this is a risk which must be faced in very bad cases.

With aseptic urine the method is harmless, it may be repeated without hesitation over and over again (during five weeks it has been done regularly), and by removing the distention, it at the same time often relieves the spasm which complicates the stricture. The patient can often make water afterwards without assistance, or at least the surgeon's trouble is much relieved.

In retention from other causes also, where urine is probably aseptic, *aspirate above the pubes in all cases of urgency and difficulty.* Should there be no exhausting bottle at hand, a vacuum is easily produced by first heating and then cooling a bottle with a tightly-fitting cork, perforated to transmit a connecting-tube. At the same time, negative pressure is not really required; an aspirating-needle, or fine trochar, is sufficient, and involves no danger so long as the surgeon sees that the intra-bladder pressure is naturally present, or is maintained by the hand over the abdomen until the needle is withdrawn. Where the bladder-wall is thick and hard from old standing inflammation, it tends to keep in a semi-contracted state; if compressed beyond this, it expands again at once like an india-rubber ball; and would draw air and organisms into the bladder, if the compressing hand were relaxed while the tube was patent.

(*b*) *Retention from enlarged Prostate* is most frequent in old men, but otherwise from previous history might be mistaken for stricture. Except where the middle lobe is enlarged alone, and towards the bladder, a finger in the rectum feeling the prostate will generally make the diagnosis plain. Should the nature of the retention be doubtful, the passage of a large instrument will remove the uncertainty. No obstruction will be felt until the prostate is reached, and there the difficulty, and a serious one, will be met with. To obviate the alteration in curve of the urethra due to the enlargement, which may be lateral as well as from below, we may use (1) a soft catheter with a "coudé" or "bi-coudé" end; (2) a metal instrument with an extra large bend; or (3) a well-curved gum-elastic catheter with stilette, passed down to the obstruction. If the catheter be gently pressed onwards while the stilette is being withdrawn, the point of the former will be raised up and may be so guided past the obstacle into the bladder.

Should the prostate bleed, as it often does freely, the eye of the catheter may be blocked ere it reach the bladder. If this be the case a catheter should be used with a stilette which plugs the "eye"; or a plug may be extemporised. A simple expedient consists in passing a piece of twisted fine wire ending in a loop down the catheter. Through the loop is inserted a strand of boiled worsted thread. The wire is withdrawn so as to pull the worsted into the eye, which is then smeared with the lubricant. After the catheter has entered the bladder, the wire and plug are withdrawn. This method can be adapted to any catheter.

Caution.—In no cases should greater care be taken to prevent septic mischief from entering the bladder than in those of prostatic enlargement, especially when relieved for the first time after an attack of retention. The whole of the urinary tract, from the kidneys to the prostate, is ready to inflame, even from the retention and the means necessary to relieve it; and, should septic fermentation once begin, the combination of increased inflammation and septic poisoning will rapidly carry off the patient. (See also *Appendix*, p. 324.)

(*c*) *Retention from Spasm of the Constrictor*, when occurring apart from any stricture, generally results from some irritation to the perinæal nerves. After an operation about the anus, or for piles or fistula, it is frequent, and is sometimes caused in children by worms. Similar spasms may also occur in the course of feverish attacks, sometimes traceable to the highly acid, and hence irritating, quality of the urine.

Treatment.—Soothing treatment such as an opiate, or perinæal fomentations, are often sufficient; failing these, the passage of a soft instrument, with gentle, steady pressure when the obstruction is reached, will be required.

(*d*) *Retention from Acute Inflammation of the Prostate.*—In these cases, the pain and feverishness of the prostatitis is an earlier and more prominent symptom than the retention. Soft catheters should be used, and even if these cause great irritation, it would be well to relieve by aspiration for several days. The instillation of a few drops of 1-1000 solution of adrenalin has been found useful in these cases

Retention from other conditions of the penis, such as urethral abscess, is to be treated on similar lines—*i.e.*, by soothing, gentle use of soft instruments, and, if need be, aspiration.

(*e*) *Urethral Calculus*, if it cannot be made to pass outwards, or seized with forceps and withdrawn, must be cut down upon. The visiting surgeon should, therefore, be sent for; but immediate relief can be given by aspiration.

(2) Possible Rupture of the Urethra.—If a case of fracture or crush of the pelvis, or severe injury to the perinæum, be admitted, the house-surgeon's duty is at once to pass a catheter and draw off the urine. Should the instrument pass easily and there be no blood, the urethra may be considered safe. Should, however, blood be oozing from the meatus, and the passage of a catheter be impossible, the urethra may be considered to be torn across. Should there be some blood and a rugged feeling as the catheter is being passed, the tear will be partial. In the latter case, the patient should not be allowed to try to pass water himself; it should be drawn off at intervals of six or eight hours, for three or four days, or a catheter tied in continuously. When there is a complete rupture—any severe retention being meanwhile relieved by aspiration—the visiting surgeon should be sent for, and preparations made for perinæal section.

(3) **Possible Rupture of the Bladder.**—Such a condition may be expected when a person with a more or less filled bladder receives a violent blow in the hypogastric region, or when the pelvis is severely crushed. The diagnosis is chiefly made from the hæmaturia, not traceable to the kidney or ureter, from the small quantity of urine obtainable, and from the collapse. The patient must be put to bed, and treated with warmth and opiates, while the visiting surgeon is sent for. Preparation meanwhile should be made for laparotomy.

(4) **Possible Injury of the Intestines.**—Where there is a penetrating wound of the abdominal wall, whether from a stab or a bullet, it may be assumed that if the abdominal cavity has been reached, the intestines or other viscera will have been injured. Only in rare cases do they escape. Again, should the abdomen have been severely crushed or heavily struck, any of the viscera may be injured without the slightest trace of violence being visible on the outside.

For penetrating wounds of the intestine it is now generally acknowledged that (at least, if the case can be seen before severe peritonitis has occurred) laparotomy should be at once performed, so that apertures may be sutured and bleeding points tied. If the probable injury could be as nearly surmised in non-penetrating abdominal injuries, the treatment would be similar.

We may, therefore, lay it down as a rule that, in all cases where from the nature or history of the injury, especially if accompanied by great shock and by vomiting and hiccough, severe injury of the intestines is suspected, the patient should be sent to bed, carefully watched, and kept absolutely quiet, while opium or morphia is administered. Nothing should be given by the mouth except a little ice to suck. Collapse may have to be treated by some of the methods indicated on p. 81. A general examination of the abdomen should be made, and special attention paid to rigidity of the abdominal wall, and to liver dulness.

Meanwhile, the visiting surgeon should be sent for without delay, and preparations made for laparotomy; a few hours may make all the difference between the success or failure of a possible operation. If we wait until intestinal contents have escaped into the peritoneum, and septic peritonitis has been well established, the patient's chances of recovery are greatly diminished, if not entirely destroyed.

(5) **Strangulated Hernia** is always a matter of great anxiety. The only question that a house surgeon may have to settle is: how far should he go in efforts at taxis before sending for the visiting surgeon, and what treatment should he adopt pending his arrival?

It is impossible to lay down definite rules for all cases, but the following general indications may be useful:—

No effort at Taxis should be made (*a*) if there be signs of local change, such as inflammation, emphysema, or bruising, at the hernial protrusion.

(*b*) If extensive efforts have been already made without success before admission.

(*c*) If symptoms have been very acute—*i.e.*, great pain, vomiting, and collapse—even although lasting for a few hours only.

(*d*) If the distinct symptoms, even though not very urgent, have continued for two or more days.

The indications of strangulation are—*locally* hardness and irreductility, pain and tenderness, loss of impulse on coughing; *remotely*, pain in the abdomen, often felt at the umbilical region, nausea, sickness, and vomiting, becoming stercoraceous, collapse with rapid weak pulse. There is generally complete constipation; but the passage of fæces which had lain low in the great intestine is sometimes deceptive.

Mr. Spence's dictum used to be: "When in doubt operate;" and the house-surgeon may assume this as the indication for sending for his "Chief." Meanwhile, the pubes should be shaved, the parts covered with a towel soaked in carbolic (1 to 20), or corrosive sublimate (1 to 1,000), and an ice bag laid over the hernia—at least, for an hour or so. The foot of the bed may also be well raised. Any great pain should be soothed by morphia. By these means the tension in the sac will be lessened, and the way prepared either for taxis or an operation, as the visiting surgeon may think fit. On the other hand, should the symptoms be slight and of short duration, the house-surgeon may very gently try taxis, but the efforts should be gentle and short. Should the parts seem inclined to yield, a slight interval may be allowed to give a chance to the cold, and to the raised position of the pelvis, when a second trial, aided with chloroform, may be made. Should this fail, a "doubt" will exist, and the case must be treated accordingly.

It is not the purpose of this work to discuss the form of operation for strangulated hernia.

Taxis is performed by first relaxing the hernial openings by raising the shoulders, and flexing and adducting the thighs (femoral, and inguinal hernia). The surgeon grasping the protrusion with one hand, draws it away, and at the same time gently compresses it, while with the other, applied at the neck, he pushes up bit by bit *in the direction of the canal-opening*. This it will be remembered runs in the same direction as the hernia in the inguinal form, while in femoral hernia, the protrusion passes up and out, and hence will have a corresponding relation to the canal.

(6) **Severe Compound Fracture or Dislocation.**—While, as elsewhere laid down, the first object aimed at should be to render all compound wounds aseptic, the injury may yet be so severe as to necessitate an immediate amputation or excision.

When the parts are severely bruised and crushed, the impossibility of saving them will be evident. In others, however, the matter may be difficult to settle. Causes for anxiety are, the absence of pulsation in the main vessels below the seat of injury, or of capillary circulation, illustrated by pressing and relaxing any vascular part; extensive stripping off, or undermining of the skin, great comminution of the bones, and a pulpy bruised state of the muscles, even though

the skin seem fairly natural. The elasticity and pliability of the skin will permit of an almost complete pounding and crushing of the deeper textures, without external marks being visible, at least at first. However, the vitality of the skin may be so injured by stretching and bruising, that it will afterwards die, although at first it looks only a little pale or livid. The patient's constitution will also have to be considered. With a vigorous patient, especially if below middle life, efforts to save a limb may be made, which it would be unwise to attempt with a broken-down or elderly patient (for Treatment, see p. 40).

(7) **Injuries of the Eye.**—(*a*) *Foreign Bodies on the surface* must be removed from the conjunctiva at once. If loose, and not immediately apparent, they will be found beneath the upper lid, which should be everted as follows:—

Direct the patient to look down to the ground; lay hold of the margin of the upper lid (or of the eyelashes), and draw it down, and away from the globe; then, placing a blunt pencil, or the flat handle of a pocket-knife upon the upper part of the upper lid to steady it, rapidly fold the lid upwards, and it will become everted. If, while it is held thus everted, the patient looks down, the upper angle of the conjunctiva can be easily explored, and any foreign particle picked off or wiped away.

Should a small particle of stone or metal have lodged in the surface of the cornea, constituting a "fire," it must be very carefully removed with a spud, the cornea having previously been rendered insensible with a few drops of cocaine (4 per cent.). The greatest care must be taken to avoid unnecessary injury to the corneal epithelium in this process.

(*b*) *Where the eye has been cut,* any escape of the vitreous humour is serious. One of the immediate risks in cuts of the eye-ball is a prolapse of the iris; therefore, if the cut should be at the centre, the pupil must be dilated with atropia; whilst, if it be at the margin, it must be contracted with eserine. A dry pad and bandage must then be applied on the closed eyelid. It is not usually necessary to do anything further at the time, unless the corneal cut should gape very widely, when it may be drawn together with a fine stitch.

(8) **Lodging of Needles beneath the Skin.**—This is a common accident, and often causes greater anxiety to the patient than the slight risk involved can account for. If the needle cannot be either seen or felt by the surgeon, no operation should be undertaken until the Röntgen rays have been called into play to reveal its exact locality. In a suitable case, begin by rendering the part bloodless, then anæsthetic, either by freezing with ether, or by injecting cocaine.

Next, incise the skin over the foreign body, and use the end of the dissecting forceps as a probe, first to detect, and then to remove it. Sometimes the intruder, though previously felt, eludes the first effort made to find it; but it is easily recognised, and seized the following day, if the wound has been meanwhile plugged with boracic lint. Joseph Bell has often demonstrated the value of this plan at his out-patient clinique in the Royal Infirmary, Edinburgh. Professor

Chiene recommends that a sharp-pointed curved bistoury be employed, first to incise the skin and then to detect the foreign body by being used as a probe. When the knife touches the foreign body, the incision is completed by cutting from within outwards, thus leaving the foreign body at the apex of a V-shaped cut. In difficult cases the X-ray screen can be used with great advantage in the search. By its aid the surgeon's knife or forceps in the tissues can be guided to the needle.

(9) **Foreign Body in the Nostril.**—Children often push seeds, or small stones, "up their nose," and cannot get them out again, because the aperture of the nostril is narrower than its cavity. When this accident has occurred, one of the best and simplest instruments for extraction is a loop of soda-water bottle wire, bent on the flat like an italic letter *f*. This may be gently slipped over the foreign body, and next made to pass behind it by raising the handle part of the loop. A pull outwards is then all that is required. Failing this method, dressing or dissecting forceps may be used to grasp and pull out the body, or to push it back into the pharyx. Great gentleness, it is perhaps needless to say, is always necessary.

(10) **Foreign Bodies in the Ear**, like those in the nose, are difficult to extract, and for a similar reason—the aperture of the external meatus is narrower than the canal beyond.

The membrana tympani closing the canal within is, moreover, a special feature in the case of the ear, necessitating greater care, lest efforts at removal should only drive foreign bodies further inwards, and so injure it. At the same time the closure of the canal within by the membrane ensures that a stream of water injected into the canal will be turned, and made to flow out again the same way, carrying any foreign body that may be present with it, or, at least, bringing it within range of a loop of wire (see section 9), or a pair of fine forceps. Besides the wire loop, syringing (see Chap. xxv.) is therefore of great service in dealing with foreign bodies lodged in the external meatus

In more difficult cases, an ear speculum, good light, and special forceps, may be required, and if there be an aural department of the Hospital, the patient should be sent there for treatment.

Insects in the meatus are best removed by the insertion of a few drops of olive oil, poured in while the patient lies down. The insect is drowned, and floated up within reach.

(11) **Threatened Obstruction to Respiration.** — Under this head may be included many urgent cases, differing very widely from one another, in their nature.

The first point to be determined is:—How far does any existing dyspnœa depend upon obstruction in the air passages, rather than upon some fault in the blood or its circulation? This is judged of by observing the movements of the thorax, and noting the amount (if any) of the sucking in of the unsupported portions of the thorax, such as the intercostal spaces, inter- and supra-clavicular notches and upper part of the abdomen, and by determining its relative

amount on the two sides. Next, we must localise the seat of obstruction, if present; for should it be below the upper part of the trachea —unless a removable foreign body—surgical interference will be useless. By auscultation and percussion we can make out signs of obstruction or disease in the air-passages within the lung. Inspection through the mouth and examination of the neck will show the condition of the pharynx, and sometimes indicate that of the larynx. Where the larynx itself is involved, the laryngoscope may be needed. Laryngeal obstruction is generally worst in inspiration, and causes crowing sounds. When both the larynx and the parts below are at fault, we must determine which is most to blame, comparing the manifest dyspnœa with the laryngeal and thoracic sounds. An indication may thus be gained, but precision is difficult to attain.

Supposing the obstruction to be at the glottis, the treatment will vary with the cause and with the views of the operating surgeon. Some of the more frequent causes of obstruction are:—

(*a*) *Swelling of the Fauces and Glottis.*—As the result of a burn—a child having tried to drink scalding tea for instance. It is difficult to say to what extent the swelling will go in any one case. Efforts should be made to limit it by giving the patient ice to suck, and applying cold continuously to the outside of the throat, and by scarifying the swollen fauces. Tracheotomy should be postponed as long as possible; but provision for it should always be at hand, as it may be required at a moment's notice. In any case, while dangerous symptoms last, every draught of cold air should be excluded from the patient, and steam from a bronchitis-kettle constantly plied round him.

(*b*) *Croup and Diphtheria.*—These may be classed together, for although well-marked examples of each are distinct from one another, many cases are very doubtful. The points of distinction are considered to be the following:—viz., that *croup* is a local inflammation and swelling of the larynx, with spasm of the glottis. It kills with dyspnœa alone. When the local obstruction is removed, improvement is rapid. *Diphtheria*, on the other hand, is (in the later stages at least) as much a general as a local disease. It is recognised to be due to a specific organism (Lœfler's bacillus) which tends specially to grow on the mucous membranes of the fauces, larynx, and trachea, and causes the formation of a false membrane like wet wash leather. This, when removed, often leaves a raw surface, but not always. Formerly, cases with merely membrane were considered as membranous croup, and those with sloughs, as diphtheria, but no such distinction is now drawn. The organism, besides causing obstruction to respiration by its local action, sets free virulent ptomaine poisons which are absorbed; hence, in bad cases, it causes a general poisoning and depression for which local symptoms do not account. Recovery is slow and often complicated with paralysis and by albuminuria.

Should diphtheria be diagnosed, the question will be—is the patient chiefly suffering from tracheal obstruction, or from general poisoning? If from the former, an operation may be considered; if

from the latter, it is, of course, unnecessary. When the local symptoms seem to be getting steadily worse, and to be the chief evil, the free entrance of air should be ensured. Symptoms are then relieved. The early use of antitoxine serum is of the utmost importance (see *Appendix*). There should therefore be no delay before searching for the organism by culture and by microscopical examination of the membrane or discharge from the throat.

If it be a case of **croup**, the chief consideration will be:—Is the obstruction becoming dangerous? If so, and if steaming, nauseants, and poultices, and possibly bloodletting have done no good, intubation or tracheotomy will be indicated.

The rules for an emergency case of tracheal obstruction from any other cause may be likened to those for simple croup.

(*c*) *Foreign Body in the Air-passages.*—Whether this be a seed, small coin, or other object, it places the patient in imminent risk of choking at any moment. It may be lodged in one of the ventricles of the larynx, or have passed down the trachea into the bronchi. If a patient be brought into hospital with a history that points to such an accident, and should no symptoms be immediately pressing, he should be put to bed as quietly and speedily as possible, no exertion being permitted, lest the foreign body be disturbed and come into a more dangerous position, or cause spasm of the larynx. All preparations for tracheotomy (see Chap. xi.) should then be made, and the visiting surgeon sent for. A bad fit of choking may necessitate tracheotomy at any moment.

No efforts should be made at inverting the patient and shaking the foreign body out, so long as it lies in a harmless place, or, unless the operator is prepared to perform tracheotomy at once. The glottis might become suddenly closed, either by reflex spasm or by direct lodging of the foreign body between the cords.

In some hospitals Kilian's apparatus has been used to extract foreign bodies from the bronchi, as a substitute for tracheotomy.

(*d*) *Foreign Body in the Pharynx.*—An obstruction by a piece of meat is generally remedied by withdrawing it, or pushing it down with the finger. Sometimes a hard body lodged in the œsophagus (below the larynx) may interfere with respiration, by pressing forwards into the unprotected part of the trachea. These rarer cases will require special treatment.

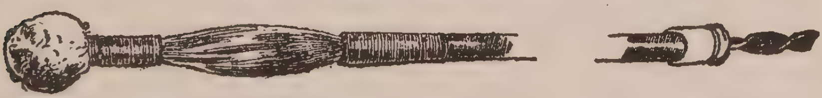
(*e*) *Foreign Body in the Œsophagus.*—Many foreign bodies, even of large size, when swallowed pass down to the stomach, and are discharged per anum. They may stick in the œsophagus, however, and either cause difficulty in swallowing, or involve risk by ulcerating through the œsophagus into the aorta or air-passages. Sometimes they lodge in pouches of the mucous membrane, and remain for a long time undetected. If inspection of the fauces and examination with the finger reveal nothing, a probang may be passed down the œsophagus. Œsophageal forceps should be of two kinds, with a lateral grasp, and with an antero-posterior grasp. If a foreign body be felt in the upper half of the passage, long forceps may be tried,

to grasp and remove it. Where there is doubt as to the position of a metallic foreign body the X-ray screen should be used. Should this endeavour fail, œsophagotomy will be indicated.

For Fish-bones and other irregular bodies, the umbrella-probang is useful (Figs. 32 and 33). This, while closed, is passed beyond the intruder, and then, when opened, is withdrawn. Frequently it brings with it the foreign body entangled in its meshes.

For Coins, the coin-catcher (Fig. 34) is useful—a gag must be used to keep open the jaws. The coin-catcher being passed, is then carefully withdrawn. If the coin comes too, the operator must be

Fig. 32.—The Umbrella-Probang: closed.



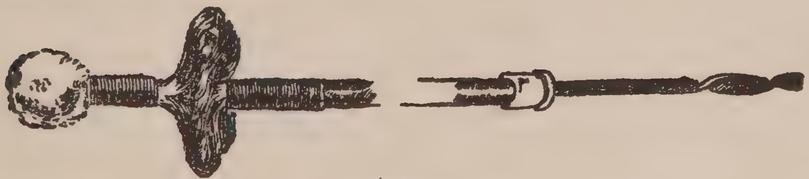


Fig. 33.—The Umbrella-Probang: open.

ready to guide it past the epiglottis with his left forefinger. It is apt to slip off the coin-catcher at this point, and either stick at the epiglottis or be swallowed again.

Artificial Respiration may be necessary after the obstruction to the breathing has been removed in any of the above cases.

In asphyxia, generally, for several minutes after breathing has ceased, the heart continues to beat. So long as it does so, the prospects of restoration by artificial respiration are good. When the heart's action, however, as well as the movements of respiration, has stopped.

Fig. 34.—The Coin-catcher.

the chances are very small. Although Milne Murray has shown by experiment that *in animals* animation may be restored by artificial respiration after both pulse and breathing have ceased, clinical experience proves that *in man* the prospects of recovery under similar circumstances are by no means so good.

Many methods of artificial respiration have been proposed, the object in all, however, is to alternately increase and diminish the capacity of the chest, so as to make air pass in and out. The simplest and readiest way is to press with the hand upon the sternum and

then suddenly relax it. Sylvester's method, which is the common and a more efficient plan, is carried out as follows: the patient's head is kept low, the chin being drawn well up, or the tongue pulled out with the forceps; the chest is raised; one person then grasps the patient's arms just above the elbow, and draws them with a sweep above the head (Fig. 35); in about two seconds, he brings them down again to the front side of the chest, against which he presses them very firmly (Fig. 36), while an assistant at the same time drives

Fig. 35.

Fig. 36.

Artificial Respiration—Sylvester's Method (table tilted).

the abdominal viscera upwards, towards the diaphragm to complete expiration. After a pause of four or five seconds, the movement is begun again. About fifteen respirations per minute are all that is required.

Howard's Method (with special reference to drowning) is the following:—

"Instantly turn patient downwards, with a large firm roll of clothing under stomach and chest. Place one of his arms under his forehead, so as to keep his mouth off the ground. Press with all

your weight two or three times, for four or five seconds each time, upon patient's back, so that the water is pressed out of lungs and stomach, and drains freely out of month. Then, *quickly* turn patient, face upwards, with roll of clothing under back, just below shoulder-blades, and make the head hang back as low as possible. Place patient's hands above his head. Kneel with patient's hips between your knees, and fix your elbows firmly against your hips. Now—grasping lower part of patient's naked chest—squeeze his two sides together, pressing *gradually* forward with all your weight, for about three seconds, until your mouth is nearly over mouth of patient; then, with a push, *suddenly* jerk yourself back. Rest about three seconds; then, begin again, repeating these bellows-blowing movements with perfect regularity so that foul air may be pressed out, and pure air be drawn into the lungs, about eight or ten times a minute, for at least one hour, or until patient breathes naturally."

Schäfer's method is based on careful experiment, and affords a maximum amount of exchange of air to the patient with a minimum expenditure of physical exertion on the part of the operator. It was devised for the restoration of the apparently drowned, but it may be also used for asphyxiated infants, and in other cases requiring artificial respiration.

The method "consists in laying the subject in the prone posture, preferably on the ground, with a thick folded garment underneath the chest and epigastrium. The operator puts himself in a position athwart or at the side of the subject, facing his head and kneeling upon one or both knees, and places his hands on each side over the lower part of the back (lowest ribs). He then slowly throws the weight of his body forward to bear upon his own arms, and thus presses upon the thorax of the subject and forces air out of the lungs. This being effected, he gradually relaxes the pressure by bringing his own body up again to a more erect position, but without moving the hands; as he does this air is drawn by the removal of pressure from the chest walls, and by their elastic reaction into the lungs. This process is repeated quite regularly and without manifest intervals between the movements, not less often than twelve times a minute; it may be done somewhat more rapidly, but fifteen times a minute would, in any case, be sufficient." In most cases of danger from respiratory failure during anæsthesia, Sylvester's is a more convenient method, at least at the first alarm.

Besides artificial respiration, efforts should be made to rouse the system by various forms of stimulation, such as by vapour of ammonia to the nostrils (burning feathers before the nose, hartshorn, etc.); ether or alcohol vapour by the lungs, by subcutaneous or rectal injection; flipping, pinching, and blistering the skin; interrupted current to the skin, muscles, or over the heart; friction and hot bottles to the extremities.

(12) **Treatment for those apparently Drowned.**—No time should be lost in trying to restore respiration. Weeds and mud

must be cleared from the mouth, and water squeezed out from the lungs and stomach, as Howard describes (p. 98). Artificial respiration by Schäfer's or other method (pp. 98, 99) should then be begun. Meanwhile, the limbs should be smartly rubbed towards the trunk with the hands or warm flannels. If circumstances permit, the patient's wet clothes may be removed and warm blankets be substituted, while hot bottles, bricks, or plates are laid against them. On no account, however, should artificial respiration be intermitted, except for a few seconds at longest, until half or three-quarters of an hour after the heart has ceased to beat.

Should spontaneous efforts at respiration return, exertions should be renewed, and at the earliest date that swallowing seems possible, brandy and water should be placed at the back of the tongue with a spoon. While circulation continues, a hypodermic of ether (20 to 30 min.), if available, may be given. After consciousness has returned, a warm drink of weak tea or coffee, beef-tea or weak alcohol should be given and the patient put to bed with plenty of warm blankets. For some days after immersion, the patient must be treated with great care, lest pneumonia should develop.

(13) **Severe Head-Injuries.**—When a patient is admitted with a severe head-injury, the question of trephining will often arise, and the house-surgeon may be in doubt whether or not to send for the visiting surgeon. As authorities differ on these matters, we can only here indicate views generally accepted :—

Do not expect Trephining—

(*a*) If the fracture seem to be chiefly on the base—*i.e.*, if blood and cerebro-spinal fluid run from the ears, or blood from the roof of the nose, or pharynx, and if there is no special paralysis or twitching pointing to localised hæmorrhage.

Treatment.—Get the bowels well opened, shave the scalp, and put on an ice-bag, and keep the patient quiet.

(*b*) If the fracture be a simple one of the vault with not very extensive depression, and unaccompanied by definite symptoms.

Treatment, as above.

(*c*) In a slight case of compound depressed fracture, where there seems good hope of keeping the wound aseptic.

Treatment.—Dress wound, otherwise treat as above.

Expect Trephining—

(*a*) In a compound fracture, with a distinct depression, with or without symptoms. *N.B.*—This includes punctured fractures.

(*b*) In any severe head-injury, with well-marked hemiplegia, aphasia, or other localised lesion, which may be cortical, whether these symptoms are early or late.

(*c*) In any head-injury where there are indications of middle meningeal hæmorrhage. This is likely to occur where the line of a fissured fracture has crossed any of the branches of the middle meningeal artery. The important symptoms are an interval of consciousness after the injury, varying from a few minutes to several hours, followed by headache, vomiting, and stupor, going on to coma,

with a slow pulse and deep snoring respiration, and dilatation of the pupil, especially on the side of the injury.

In doubtful cases the nature of the fluid drawn off by lumbar puncture may be of service in diagnosis.

(14) **Cut Throat.**—The course to be pursued includes—

(*a*) Arrest of hæmorrhage.

(*b*) Treatment of injured trachea or œsophagus.

By the time cases of cut throat are brought under the surgeon's notice, often either the patient is dead, or bleeding has spontaneously ceased. The first duty of the surgeon will be, however, to look for and stop any bleeding that may exist. Cautiously he must remove blood-clots, and sponge the wound with an antiseptic lotion, secure bleeding points with forceps, and carefully ligature them. Next, he must examine the extent of the wound, and close with catgut stitches any apertures in the air or food-passages, should they have been made. In such cases, he may also approximate the rest of the wound, but without entirely closing it, lest any discharge be pent up and burrow either into the wounded trachea or gullet, or under the fascia of the neck.

In cases where the cut has not wounded the trachea or gullet, the chances of septicity are much less, and an attempt should be made to render the wound aseptic, after which it may be closed with sutures. Watch should be kept, however, and on any sign of discharge-accumulation, the wound must be opened up again.

The after-management of the wound must be conducted so as to prevent discharge from entering the trachea or œsophagus, or from burrowing under the cervical fascia. The neck should be kept at rest, with the head bent forwards.

In cases where the thyro-hyoid membrane has been wounded, there may be great swelling and inflammation about the epiglottis, extending into the larynx. In bad cases, tracheotomy may be required, and, in anticipation of danger, *it is often best to operate at once*. Owing to the presence of dysphagia, it may be necessary to feed the patient with a catheter passed into the œsophagus, or nourish him by nutrient enemata till the swelling subsides.

In all cases, the constant presence of a skilled attendant is of the greatest importance.

Anæmia from loss of blood (p. 78), shock (p. 81), or excitement, must be treated by appropriate remedies.

N.B.—In all suicidal or assault cases, notes of the injury should be be taken on the spot, and if possible, a consultation with a colleague should be obtained.

CHAPTER X.

EMERGENCY CASES (*Continued*).

Contents.—B. Cases of Poisoning—Poisons most frequently selected—Classification of Poisons—"Emergency" Apparatus: the Stomach-Pump and its Syphon Substitute—General Treatment—Treatment for Special Poisons—Treatment for Poisons most commonly taken.

B. Cases of Poisoning.

CASES of poisoning are always anxious; acute ones are urgent. As treatment depends on diagnosis, no time is to be lost in forming it. Often the statement by the patient or his friends is sufficient. When this is not to be had, the diagnosis must be made on other grounds.

Poisons most frequently selected in Suicidal Cases.—Apart from the symptoms observable, it is of interest and importance to know what poisons are most frequently selected by suicides, or taken by misadventure. Morselli (On suicide—*International Scientific Series*, 1881), says—"In the aggregate of suicides which happened in England and Wales in 1863-74, the following poisons seem to have been always more used than any others; prussic acid, cyanide of potassium, laudanum, oxalic acid, arsenic, strychnine, the vermin-killer, and oil of bitter almonds; whilst in the second and third places are always found caustic acids, mercury, preparations of opium and morphia, vegetable narcotics, phosphorus, and salts of copper; lastly, though rarely chosen, come chloral, chloroform, paraffin, belladonna, ammonia, cantharides, salts of lead, zinc, and potassium.

It is remarkable that caustic alkalies are not found on the list. To compare with this statement of the use of poisons in England, the following Table has been drawn up from the Registrar-General's Report for Scotland for the five years preceding 1889, showing the number of deaths by poisoning, both suicidal and accidental. It will be seen that opium (generally as laudanum) heads the list, and that prussic acid is much less used than it is in England.

1881-1885.

	Accident.	Suicide.	TOTAL.
Opium (and Morphia),	80	42	122
Carbolic Acid,	8	5	13
Lead,	11	0	11
Chloroform,	10	1	11
Sulphuric Acid,	8	3	11
Chloral,	6	3	9
Belladonna and Atropia,	8	0	8
Phosphorus,	6	2	8
Strychnia,	4	4	8
Alcohol,	4	0	4
Cyanide of Potassium,	1	3	4
Hydrocyanic Acid,	0	4	4
Arsenic,	0	3	3
Spirit of Salt,	3	0	3
Salt of Sorrel,	2	1	3
Herbs,	2	0	2
Hydrochloric Acid,	0	2	2
Nitrate of Potash,	0	2	2
Nitric Acid,	2	0	2
Oxalic Acid,	0	2	2

As these, however, are all deaths, the next table is given to show the various cases treated for poisoning in the Edinburgh Royal Infirmary from 1877 to 1887 inclusive—eleven years. Most of the cases recovered.

Opium,	60 cases.	
Acute Alcoholic Poisoning,	30 ,,	
Suspected Poisoning,	12 ,,	
Coal Gas,	6 ,,	
Strychnia, Morphia, Phosphorus, Chloral,	4 ,,	each.
Ammonia, Oxalic Acid, Paraffin, Belladonna,	3 ,,	,,
Chlorodyne, Iodine, Lead, Insolation,	2 ,,	,,
Irritant, Atropia, Spirit of Salt, Sulphuric Acid, Aconite, Corrosive Sublimate, Bow's Liniment, Prussian Blue, Carbolic Acid, Chloroform, A. B. C. Liniment, Croton and Opium, Cyanide of Potassium, Creosote and Opium, Salt of Sorrel, Prussic Acid, Arsenic,	1 ,,	,,

Classification of Poisons.—(1) *Irritants*, such as arsenic and cantharides, irritate and inflame; symptoms are delayed. *Corrosives* have immediate action; they soften and destroy the mucous membranes—*e.g.*, caustic alkalies, strong acids, corrosive sublimate, also to a less degree, oxalic acid.

(2) *Narcotics* or cerebral poisons, producing stupor, delirium, convulsions, or coma—as opium, hydrocyanic acid, poisonous gases.

(3) *Narcotic-irritants* combine the effect of the above in greater or less degrees—*e.g.*, strychnia, aconite, hemlock.

Symptoms and Diagnosis.—When diagnosis has to be made from symptoms, the following tabular form, modified from that given by Murrell in his excellent work on "What to do in Cases of Poisoning," will be found useful:—

Collapse.—Prominent in irritant and corrosive poisons, and in all others towards the end.

Coma.—In opium and morphia, alcohol, chloroform, chloral, coal gas, prussic acid.

Excitement.—In alcohol (early stage), belladonna, hyoscyamus, cannabis indica.

State of Pupils.—*Contracted* in opium and morphia, and alcohol (sometimes). *Dilated* in belladonna and atropine, hyoscyamus, tobacco, and alcohol generally.

State of Skin.—Dry in belladonna and atropine Moist in opium, aconite, and in collapse.

Time Symptoms take to appear.—Developed at once in corrosive poisons and in hydrocyanic acid. In others the time varies with strength and dose of poison, condition of stomach as to food, and idiosyncrasy of patient. Effects of arsenic and phosphorus are often delayed.

Smell of Breath.—Characteristic in laudanum, alcohol, carbolic acid, etc.; in phosphorus poisoning there is a smell as of garlic.

State of Mouth.—Mucous membrane made white and softened by caustic alkalies and mineral acids (nitric turns it afterwards brown); also by corrosive sublimate and strong carbolic acid. Dry from belladonna, atropine, and opium.

Vomiting, Colic, Purging.—In strong irritants, also in arsenic, antimony (with great depression), digitalis, lead, colocynth, colchicum, and phosphorus.

Nature of the Vomit, if any.—Bloody and coffee ground in irritant poisons. Black or dark green, luminous in the dark, with odour of garlic, in phosphorus.

"Emergency" Apparatus.—Every hospital, and, indeed, every general practitioner should be provided with emergency apparatus and the necessary antidotes and hypodermic remedies, either in solution, or preferably in the form of tabloids, with directions at hand to aid the memory in case of need.

The Stomach-pump.—A necessary instrument to have in readiness is the stomach-pump, or, preferably, a stomach tube and funnel.

To pass the Tube.—Smear the tube with olive oil, vaseline, or glycerine; bend its end nearly to a right angle; make the patient open the mouth, and hold the head well back at first. Pass the tube straight to the fauces, avoiding the tongue as much as possible, and gently push it on, directing the patient to "swallow it." The left forefinger may be used to guide the tube past the epiglottis when there is much coughing and spasm of the constrictors. As soon as

the tube is in the œsophagus, the patient's head must be brought forward, and the tube pushed on with a somewhat upward lift.

Should the patient's jaws be voluntarily or involuntarily locked, considerable force may be required to force them open. A screw-gag is made for the purpose; but failing this, a screw-driver or similar instrument inserted between the teeth will suffice to make a beginning, wedges of wood or cork can then be introduced to keep the ground once gained, and the jaws may be forced open more and more until sufficient room is gained to pass the tube. To prevent its being bitten, either side-gags of wood or cork may be kept in place, or a centrally perforated one may be used.

Syphon Substitute for Stomach-pump.—All that is really required is an india-rubber tube, which, when passed into the stomach, is long enough to have its end brought below the level of the stomach, so as to produce syphon action. After the tube is in the stomach, fluid must be poured down through a funnel, by a syringe, or even from the operator's mouth on an emergency (*Harvey*). When the tube is filled, its outer end must be compressed, and brought lower than the end within the stomach, when the fluid contents of the stomach will flow out, by syphon action. As the exhausting action is gentle, unless a very long tube is used, this method, while equally efficient, is safer than the stomach pump, as there is less risk of injuring the mucous membrane. One great advantage, moreover, is the impossibility of its going out of order, as it contains no valves.

If desired, it would be easy to attach a T-tube, so as to have a different entrance and exit pipe.

General Treatment.—(1) Get rid of as much poison as may still remain unabsorbed in the system. (2) Neutralise it, and diminish its effects. (3) Give chemical and physiological antidotes, and treat symptoms.

I. For poisons taken by the mouth and not already ejected, give emetics :—

(1) *Sulphate of zinc* 20 to 30 grs. in half a tumbler of warm water.

(2) *Ipecacuanha* in powder, in 15 to 30 gr. doses in warm water, or ʒiij to ʒvj doses of Vinum Ipecacuanhæ.

(3) *Mustard*, a table-spoonful in a tumbler of warm water.

(4) *Apomorphia*, $\frac{1}{10}$ gr. hypodermically; $\frac{1}{8}$ gr. by the mouth; or apomorphine hydrochloride, $\frac{1}{10}$ gr., with strychnine hydrochloride $\frac{1}{60}$.

(5) *Sulphate of Copper*, 10 grs. in warm water (apt to irritate).

(6) *Tepid water*, large draughts of, soapy, greasy, or salt—followed by irritation of the fauces with the finger or a feather.

If necessary, any of these emetics may be repeated once or twice.

N.B.—Corrosive and the more irritant poisons which damage the mucous membrane of the stomach, contra-indicate emetics, and still more the use of the stomach-pump. However, they usually cause vomiting by their own action. Narcotics, such as morphia and opium (unless in excessive quantities, when it irritates), make vomiting extremely difficult.

Except when contra-indicated as above, wash out the stomach with the stomach-pump in all cases where vomiting cannot be produced, or when any doubt exists as to poison remaining in the stomach after vomiting.

II. Neutralise and dilute *mineral acids* with *alkaline carbonates,* well diluted in water or milk; with lime water; or with chalk, whiting, whitewash, wall plaster, or magnesia (heavy or the heavy carbonate), suspended in milk or water—or with water alone.

Neutralise *alkalies* with *acids,* such as weak acetic, or mineral acids, lime juice, orange or lemon juice.

For both acids and alkalies give demulcents, such as olive oil, milk, thick gruel, white of egg and water or milk, gum and water.

III. Treat collapse as for shock (see p. 81).

Special Treatment.—In carrying out the directions as indicated in the Table of Treatment for Special Poisons given below, it will be understood that the following *general* methods apply to *all,* unless where statement is made to the contrary.

(1) *Emetics* and stomach-pump.

(2) *Stimulants,* where there is collapse.

(3) *Artificial respiration* in all sudden and extreme cases, especially where the heart beats after respiration has ceased.

(4) *Massage* in the form of superficial effleurage to stimulate the heart, and of muscle-kneading to increase metabolism; this, however, slows the pulse, and increases muscular activity (see under *Massage*).

(5) *Faradic current* where stimulation is needed (see under *Electricity*).

Where any of the above methods are especially applicable, they are mentioned in the Table. The cases are also supposed to be acute.

Drugs marked with a star (*) are to be given hypodermically.

TREATMENT FOR SPECIAL POISONS

POISON.	TREATMENT.
Acid, Carbolic,	½ oz. Epsom, or Glauber's salts, in ½ a pint or more of water. Emetics, or stomach-tube, and wash out with the above. White of egg in water. Olive oil. Treat for shock (p. 81) if present.
Acid, Oxalic, .	(See detailed Treatment, p. 109).
Acid, Prussic, .	(See detailed Treatment under *hydrocyanic acid,* p. 109).
Alcohol, . .	(See detailed Treatment, p. 108).

Poison.	Treatment.
Arsenic.	1. *Freshly prepared* hydrated ferric oxide,† in tablespoonful-doses given with a little water. Sub-carbonate of iron. Dialysed iron, followed immediately by common salt. Magnesia. 2. Olive or castor oil, and demulcents. 3. Warmth. Morphine * to allay excessive pain.
Atropia (Belladonna),	1. Tannic acid, hydrate of magnesia, or animal charcoal. 2. Morphine * in large doses, or pilocarpine.*
Chloral,	1. Rouse and stimulate as for opium and morphia poisoning. 2. Strychnine * $\frac{1}{28}$ gr.
Chloroform,	See *anæsthetics.*
Corrosive Sublimate,	1. White of egg, wheat flour or gluten, in water or milk, or milk alone. *Followed* by emetic.
Lead (Acetate),	1. Epsom or Glauber's salts, or weak sulphuric acid. 2. Milk and white of egg.
Opium or Morphia,	(See below)
Phosphorus,	1. Special emetic, repeated 3 gr. doses of sulphate of copper (or other emetics). 2. Sulphate of copper, afterwards continued in 1 gr. doses every quarter of an hour. 3 Magnesia in demulcent drinks. 4. Avoid oils or fats.
Strychnine,	1. Chloroform—the vapour—or administered internally, or ether. 2. Tannic acid. 3. Chloral, paraldehyde, or nitrite of amyl. 4. Curare (?). 5. Artificial respiration.

† Treat tincture of ferric chloride, or strong solution of ferric sulphate, with slight excess of ammonia. Collect precipitate on muslin strainer and wash out all odour of ammonia (*Wormley*).

The more common Poisons.—Having thus discussed briefly the treatment of cases of poisoning generally, we shall now describe in greater detail the symptoms, diagnosis, and treatment of some of the more common forms met with.

(1) **Opium** (generally taken as laudanum) or **Morphia-poisoning** begins with cerebral excitement, and soon passes into giddiness, drowsiness, and stupor, succeeded by perfect insensibility. From this state the patient may at first be roused, but he speedily relapses. Afterwards it becomes impossible to rouse him. Pulse at first small, quick, and irregular: respiration hurried; skin warm and moist; all other secretions suspended. When coma sets in, breathing is stertorous; pulse slow and full; pupils at first contracted, towards a fatal termination, dilated. Face placid, pale, and ghastly; eyelids heavy; lips livid. An excessive dose may excite vomiting by its irritant action, otherwise vomiting is not easily produced. In the worst cases muscles are flabby and relaxed; lower jaw drops; pulse is feeble; sphincters are relaxed.

Diagnosis is to be made from alcoholism and from apoplexy with contracted pupils—*i.e.*, in the pons varolii (*Wilkes*).

Judge by the history and smell of the breath (though alcohol and opium may have been combined). In many cases, correct diagnosis may be impossible, until the stomach-pump reveals the contents of the stomach.

Treatment.—Emetics—or, better, washing out the stomach with the stomach-tube. Preserve the contents of the stomach for after-examination. Rouse the patient by douching the head, slapping with wet towels, tapping on the forehead, faradic current; and, *unless he seems too weak*, force him to walk about. Have relays of assistants, two at a time, to drag him about. Stimulate him by hot coffee. Murrell advises a pint of hot coffee per rectum.

Permanganate of potassium has been found to oxidise and so neutralise the active properties of morphia when brought in direct contact with it. It is, therefore, a valuable *local* antidote in opium- and morphia-poisoning; but its value by hypodermic injection is considered very doubtful. After the contents of the stomach have been removed, a weak solution of permanganate of potassium should be used to wash out the cavity, and this washing out is to be repeated every half hour, because the morphia circulating in the blood is secreted into the stomach. The drug may also be given by the mouth, in 15 grain doses, and twice or thrice repeated.

Give atropine, $\frac{1}{20}$ of grain subcutaneously, repeated in a quarter of an hour. Some advocate $\frac{1}{4}$ to $\frac{1}{2}$ grain, repeated in two hours. Patient may be allowed to sleep, when the tendency to intense stupor has passed off.

(2) **Alcohol.**—**Acute**—When an excessive dose of strong alcohol is taken, or when raw spirits are given to children, the drug acts as a rapid poison, and sometimes kills on the spot. If this does not happen, the patient becomes more or less collapsed; pupils are dilated—often contracted; muscles relaxed. The patient is help-

less, becoming soon comatose. If left in this state, he may rapidly sink.

Treatment.—Wash out contents of stomach, or give emetics; stimulate by warmth, and hot coffee per rectum, and rouse by means similar to those recommended for opium-poisoning.

(3) **Hydrocyanic (Prussic) Acid**, and cyanide of potassium, used in photography, produce similar symptoms. Their effect is extremely rapid—from 1 to 2 grains of the pure hydrocyanic acid have proved fatal, and larger doses are certain. In doses insufficient to kill at once, the poison produces insensibility, pallor and swelling of the face, slow laboured respiration; eyes are fixed and glazed; the body becomes rigid—often convulsed.

Treatment.—If there is time, (1) emetics, and stomach-tube; (2) cold affusion to the head, and stimulants; (3) chlorine, by the mouth, in the form of weak solutions of hypochlorite of sodium or of calcium, or inhaled as gas, which is formed by pouring dilute acetic or hydrochloric acid on either of the above salts; (4) mix 10 grs. sulphate of iron with ʒi tincture of iron and ℥i of water; when this has been taken, give 20 grs. carbonate of potassium in ℥i of water. This renders insoluble 110 min. B. P. acid (*Squire*).

(4) **Oxalic Acid** causes symptoms like those of an irritant poison.

Treatment.—Neutralise with lime in the form of chalk, whiting, or plaster. Avoid soda, potash, or ammonia. Give demulcents; treat shock (p. 81), and clear out bowels with castor-oil.

CHAPTER XI.

TRACHEOTOMY. MINOR SURGICAL OPERATIONS.

Contents.—A. Tracheotomy.—Requisites for the Operation—The "High" Operation—The "Low" Operation—Caution !—After-Treatment—Intubation of the Larynx.

B. Minor Surgical Operations.—(1) Removal of the Tonsils—(2) Amputation of the Fingers or Toes—(3) Treatment of In-growing Toe-nail—(4) Tapping a Hydrocele—(5) Paracentesis Abdominis—(6) Paracentesis Thoracis—Use of the Aspirator—(7) Air in Veins—(8) Circumcision—(9) Phymosis—(10) Paraphymosis.

A. Tracheotomy.

Tracheotomy, or Laryngotomy, is rendered necessary whenever death threatens from laryngeal obstruction which is not at once amenable to other treatment.

Requisites for Tracheotomy.—Chloroform, ether, or local anæsthetic syringe and fluid (see Chap. iii); gauze pads for sponging; ligatures; scalpel; dissecting-forceps; Péan or other compression

forceps; sharp hook; director; aneurism needle; scissors; bone forceps (small); syringe with red-rubber catheter attached to suck fluid out of the trachea, feathers, and tracheotomy tubes. For uncomplicated cases the usual forms are sufficient.

Durham's pattern is invaluable when the trachea lies deep in the midst of greatly swollen tissues (Fig. 38). The angled tubes of R. W. Parker (Fig. 37), are preferred on anatomical grounds, but the inner

Fig. 37.—R. W. Parker's Tracheotomy Tube: *a*, outer; *b*, inner.

tube is liable to become bent at the cut away portion, and so to jam; moreover, thick mucus is apt to cake at the same point in the outer tube. The small flange for securing the inner tube had better be removed, when good nursing cannot be had, in case it should prevent the tube from being easily removed if blocked.

The surgeon generally enters the trachea above the isthmus of the thyroid gland. This is known as the "high" operation. It is more easily accomplished than the operation below the level of the isthmus,

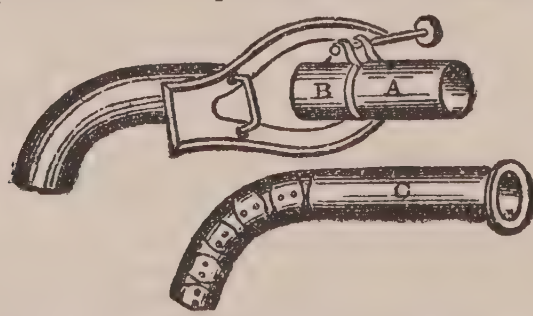


Fig. 38.—Durham's Lobster Tail Tracheotomy Tube. The outer tube (A) can be projected at any distance beyond the shield and fixed there by means of the screw and collar at (B). The inner tube (C) is provided with a jointed tail which enables it to pass in and out of the outer tube.

where a more difficult procedure is required, since here the trachea lies deeper. Indications for Tracheotomy are presented by the increasing dyspnœa of the patient. There is no time to delay when there is progressive cyanosis, embarrassed respiration, and sinking-in of the intercostal spaces, false ribs, and root of the neck. The anæsthetic, especially chloroform, must be given with great care, and

very little is required. In adults novocain suits admirably when there is no emergency. It is well to roll the patient (especially if a child) in a towel, so that the arms may be secured by the side. The neck and chest should be bared, the neck laid over a pillow and the head curved back so as to pull the windpipe from out the thorax, and increase its cervical extent. The head must be kept perfectly steady and straight. An accurate knowledge of the landmarks of the neck is essential. Where one cannot make out the pomum Adami, as in young children, the more resisting ring of the cricoid cartilage may be felt, when the trachea is traced from below.

First Stage.—The surgeon, standing on the patient's right side, with the palm of his left hand towards the patient's chin, lays his left forefinger on the tip of the thyroid cartilage, while the thumb and middle finger on each side serve to fix the trachea; and makes an incision prolonged from below his finger, through skin and fascia, exactly in the middle line, over the thyroid isthmus, to about an equal distance beyond it. Skin, fat, and fascia, with perhaps a few twigs of the anterior jugular vein, are thus divided. Bleeding points are secured with forceps.

Second Stage.—The surgeon now inserts his finger into the wound and feels the cricoid cartilage distinctly. It may be necessary to push aside some fat with the handle of the knife in order to do this. He divides now, with a small transverse cut, the fascia over the cricoid, and slips a blunt director underneath it, so that he strips this fascia and the isthmus of the thyroid together with a few venous radicles which run into it, from off the anterior aspect of the trachea. As the trachea in children is rather yielding, and the fascia and isthmus comparatively strong and adherent, it is a better plan to thrust one blade of a compression-forceps under the fascia and isthmus on each side, and divide the tissue between the forceps as far as necessary. In this way, the upper two or three rings of the trachea are bared, and can readily be felt by the finger-tip. The knife is then held short, and plunged into the windpipe for a quarter of an inch with its cutting edge directed upwards and the incision slightly prolonged. The knife should then be withdrawn, and its handle, failing a tracheal dilator, introduced; this, being rotated transversely to the wound, permits of the ejection of mucus, and acts as a director along which the tube may be now introduced.

Should the violent upward movements of the trachea during forced respiration prove troublesome, fixation may be obtained by laying hold of the compression-forceps, which grip the isthmus of the thyroid gland and its fascia, or, by inserting a sharp hook to one side of the middle line, the parts may be steadied. The trachea is then readily incised.

In the "*low*" *operation*, the operator must clearly bear in mind that the chief difficulties are met with as soon as the deep fascia of the neck is entered. The anterior aspect of the trachea below the isthmus is clothed with the inferior thyroid veins, which may form a complex anastomosis, and here also an abnormal thyroidea ima

artery may appear. It may be necessary to push up the thyroid isthmus, and in the case of infants to push aside the thymus gland.

As soon as the operator has carried his incision between the depressors of the hyoid, secured the superficial veins, and opened the deep fascia, then his troubles begin. The deeper veins must be separated with the handle of the knife, or grasped with compression-forceps wherever they cross, and the rings of the trachea should be fairly exposed and cleared before they are divided.

Should there be great hæmorrhage with urgent dyspnœa, it is well to open the trachea during the bleeding, after having allowed it to continue for a few seconds, since the venous bleeding will relieve the engorged right heart. The hæmorrhage and dyspnœa will cease with the first respiratory efforts, and the inspired blood will be mostly expectorated. As far as possible, however, the opening of the trachea should not take place till hæmorrhage is checked. The inspiration of blood is a fruitful source of subsequent pneumonia.

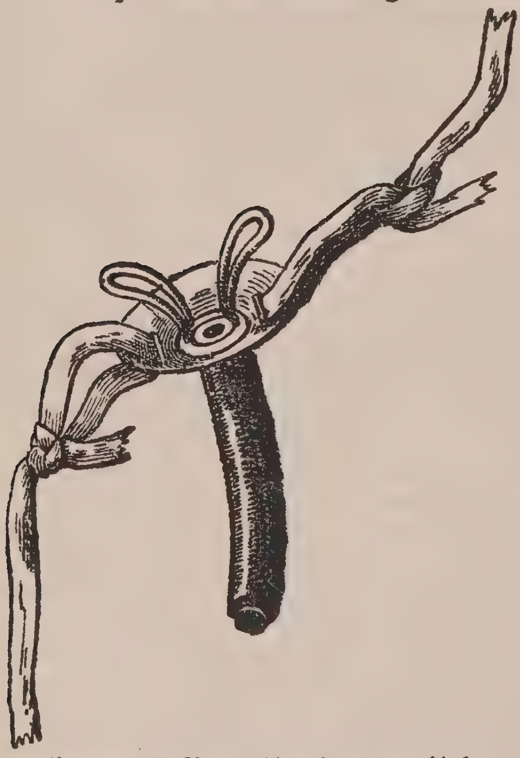


Fig. 39.—Ordinary Tracheotomy Tube. Tapes tied in.

The surgeon must impress on his assistants the importance of keeping the head steady, and must ever bear in mind that misfortunes may attend any deviation of the incision from the middle line. In children, the trachea is soft and yielding, and is readily missed—more especially if the surgeon passes a little to one side or the other.

In very urgent adult cases, a rapid vertical incision from the apex of the thyroid downwards will expose the crico-thyroid membrane, and by incising this transversely, in order to avoid the crico-thyroid artery, rapid entrance can be obtained to the respiratory tract (*Laryngotomy*). Again, it is possible still further to gain room by proceeding next to divide the ring of the cricoid (*Laryngo-tracheotomy*).

Caution!—The operator should always stand aside at the moment that the trachea is opened. Its contents are ejected with much force, and diphtheritic infection is not rarely conveyed in this manner.

The tube should be securely tied in, taking care that the tapes do not obstruct the veins of the neck. A little iodoform should be smeared over the raw surfaces, and in the case of diphtheria suitable antiseptic applications used. The inner tube should now be inserted, and the patient put back to bed. Begin antitoxine treatment at once in diphtheria, if it has not already been given (see *Appendix*).

After-treatment.—If all has gone well, the condition is now in marked contrast to the previous distress. The breathing becomes so gentle and easy that it is barely perceptible, and quiet sleep comes on. The future of the case depends largely on careful nursing. There should be two nurses to relieve each other. The patient cannot, without danger, be left for a moment alone. Expectoration must be favoured, and this is to some extent promoted by keeping the atmosphere of the room moist. For this purpose a species of tent may be rigged up around the patient by means of blankets over clothes-screens, and the steam from a couple of bronchitis-kettles carried into it. This should not be overdone; a steam bath is not desired. Uniform temperature of 70° F. should be preserved, all draughts avoided, and good ventilation secured.

Over the mouth of the tracheotomy tube a double fold of fine gauze, wrung out of warm water, should be laid in order to filter the air, and clots or mucus when ejected should be at once dexterously brushed away by the nurse. At first the inner tube should be removed and cleansed every twenty minutes, if it is not coughed out during the interval. It should be well cleaned in warm carbolic lotion, anointed with a little glycerine and water, the superfluous moisture dried off, and reinserted. It is customary to clean the lumen with ordinary poultry wing feathers. They should be carefully washed in carbolic lotion or boiled, and have the loose barbs removed, a precaution which is the more necessary when they are used to clear the tube *in situ*, or to stimulate the mucous membrane of the trachea.

Every time the patient awakes, he should be fed. Brandy and beef-tea may be given freely, and digitalis in the event of impending cardiac failure. A close watch should be kept on the urine and condition of the chest.

At the end of twenty-four hours the tube may be changed, a duplicate being ready. There is usually little difficulty, but it is well to have a director at hand. By pressing the end of the tube on one side of the tracheal wound, that edge is readily depressed, and the aperture rendered patent, and introduction thus facilitated. The tube is again changed at variable intervals of two or three days, according to the nature of the case. It is finally taken out about the fifth or seventh day; but this again will vary according to circumstances. As soon as the patient can breathe without it, let it be taken out, provided the disease or cause of obstruction has been removed. When spasm develops on its removal, some difficulty may be experienced in getting the patient to use the larynx again for respiration. A new tube should be substituted, with a perforation on its convexity,

through which the patient may speak when the finger closes the external opening. He is now encouraged to breathe as well as speak through the normal passages, by blocking the tube with a grooved cork, or by increasing layers of moist muslin, etc. The tube may, of course, be dispensed with entirely, whenever the respiration is perfect. After removal the wound rapidly closes. Emphysema rarely gives rise to trouble. The difficulty due to great swelling of the neck by which the trachea becomes buried, and the tube cannot pass deep enough, is obviated by using Durham's tube. In every case of diphtheria, isolation of the patient, and complete disinfection of every article that quits the room, must be practised. The swabs and cloth used for the tubes should be destroyed, and great vigilance exercised over the attentions of friends and relatives.

Should a sudden call for tracheotomy arise from the pressure of a tumour, and one has reason to believe that the obstruction is direct and high in the neck, the "low" operation must be performed. Here again the importance of feeling the trachea, which is often displaced to one side, and also seeing that it is cleared of veins before opening, is to be remembered. In adults, a pair of strong shears, or even bone pliers, may be required to divide ossified cartilage.

Laryngotomy is a simpler operation than tracheotomy, and can be performed very quickly. A fold of skin opposite the cricothyroid membrane is pinched up longitudinally and transfixed. A short vertical incision between the sternohyoid muscles is then followed by a transverse puncture of the membrane with a thin-bladed knife, and in the track of this is inserted the closed end of a rather fine blunt-pointed pair of scissors. These being forcibly opened make a way for the laryngotomy tube which should have an obturator with rounded end to facilitate introduction.

Intubation of the Larynx.—The results obtained by the use of O'Dwyer's intubation tubes are quite satisfactory in cases of diphtheria in hospitals where skilled assistants are always available. In private practice, however, intubation is contra-indicated. Should anything go wrong with the tube, the patient would be dead before the doctor could be found. Should intubation fail, one must be prepared to perform tracheotomy at once. The intubation instruments of Collin (Paris) are decidedly the best (see Fig. 40). A laryngeal tube of suitable size is selected, threaded, and affixed to the introducer by means of its obturator. The child, pinned in a towel to secure its arms, is laid flat on a narrow table, as if for tracheotomy. This position for intubation was introduced by the late Dr. Moon, of the Edinburgh City Fever Hospital. The gag is inserted on the left side of the mouth. The operator, standing at the patient's right, passes his left forefinger behind the epiglottis, so as to feel the rima, glides the introducer along his finger, and slightly tilting the point forward, as if making for the Adam's apple externally, avoids the œsophagus, and the larynx is entered. The mechanism of detaching the obturator forces the tube onwards, and it is now pushed home with the left forefinger. If this be successfully accomplished there is a violent

paroxysm of coughing, mucus and membrane are violently expelled, after which respiration becomes tranquil. It is well to have the laryngeal tube mounted with the central core of a banjo D string, the wire being removed, except at the portion which lies between the teeth. This serves to withdraw the tube at once if we have planted it within the œsophagus, or at any moment if it become blocked. It may be left *in situ* secured by a loop round the patient's ear, and fastened with adhesive plaster. The wire cannot be cut by the teeth. The hands should be secured in some fashion to prevent the child pulling at it. Intubation requires practice on the cadaver, but the necessary dexterity is speedily acquired. The child may become cyanosed during the operation. The beginner is apt to intubate the œsophagus, and may require to make several attempts

Fig. 40.—Collin's Intubation Instrument

before he succeeds. The tube should be withdrawn about the fourth day, and reintroduced if required. Removal by the extractor is not easy. The beaked extremity is to be passed within the orifice of the laryngeal tube, the blades expanded, and so locked within the tube; extractor and tube are removed together. The shorter tubes of Collin can also be expressed by the fingers applied externally. As a rule, feeding presents but little difficulty if the child be kept recumbent, and it soon gets used to the tube.

B. Minor Surgical Operations.

(1) Removal of the Tonsils.—In adults who have the sense to keep their mouth open, this operation is a simple one for the surgeon, as well as nearly painless for the patient, especially if a 5 per cent. solution of cocaine has been previously rubbed well over the fauces; but where a gag and an anæsthetic are required, the operation is often very troublesome.

In children a general anæsthetic should be given, and the agent most generally employed is ethyl chloride (3 c.c.). A guillotine should be used for all prominent tonsils. Those requiring removal which are depressed below the surface have to be dissected out with scissors,

The guillotine method now most popular is that developed by Messrs. Whillis and Pybus. It is described by W. G. Porter in his handbook as follows:—"The guillotine they use is a modification of the Mackenzie pattern, of which the shaft is long and specially strengthened, while the handle is set at an obtuse angle; a small size is employed (No. 1), and the blade is blunted before use. The surgeon stands on the right of the patient, who is placed in the supine position, with his head turned towards the right side for the removal of the right tonsil, and with his head in the supine position for removal of the left tonsil. The mouth is opened with a gag, but a tongue depressor is not used; a general anæsthetic is employed, either ethyl chloride or ether. The ring of the guillotine is hooked over the lower pole of the tonsil, and the hand is then depressed: the forefinger of the left hand presses on the outer part of the anterior pillar of the fauces and drives the tonsil through the ring; the blade is then driven home with the right thumb."

When performing the operation the surgeon will find that the effect of depressing the hand which holds the guillotine is to lift the tonsil up into the soft palate which then bulges. It is upon this bulging part of the soft palate that the surgeon presses with his left forefinger or thumb in order to drive the tonsil through the ring. The advantage of having a rather blunt blade of the tonsillotome is that it, following the path of least resistance, tears through the areolar tissue outside the fibrous capsule of the tonsil, and thus enucleates it. This method is difficult at first and requires practice.

(2) **Amputation of the Fingers or Toes.**—This may be called for on account of bruising, or, in the case of the fingers, from sloughing following whitlow.

(a) **Amputation of the Fingers.**—For the second phalanx onwards to the point, as much should be left as possible, and in most cases the surgeon's only duty will be to trim the parts, and snip off bone that cannot be covered in by the soft tissues.

In working-men, the first phalanx may sometimes be left with advantage (though this is contrary to the usual teaching), as it moves with the remaining fingers, and helps to strengthen the grasp. A stump of the index-finger, as giving a point of opposition to the thumb, is specially useful. The idea that the first phalanx has no independent power of flexion and extension was long since overthrown by Duchenne. After amputation, it remains stiff, only as the result of sloughing and inflammation.

Amputation at the First or Second Interphalangeal Joint is thus performed:—After applying a tourniquet above the wrist, the surgeon completely flexing the two bones, cuts on the distal end of the more proximal one, and thus opens into the joint (Fig. 41). He then cuts a long palmer flap either by dissection from without, or by carrying a narrow-bladed bistoury round the proximal end of the more distal phalanx, and cutting from within outwards. One or two small vessels generally require to be ligatured or twisted.

In Amputation through the Second (or First) Phalanx, a similar

long palmar and short dorsal flap is to be adopted, the bone being divided with bone forceps. Some prefer two equal lateral flaps, cut from without.

At the Metacarpo-phalangeal Joint, the oval or V-shaped incision is most frequently adopted. A cicatrix on the palm is to be avoided.

The parts are to be cleansed and purified as usual, a tourniquet applied, and an anæsthetic administered. An assistant steadies the hand, and, if the doomed finger be the middle or ring-finger, holds the adjacent finger aside. The surgeon then, holding the finger with his left hand, enters his knife about half an inch above the knuckle (nearer the wrist), and then carrying his knife straight down as far as the joint, next directs it obliquely down the side of the first phalanx to where the web joins the finger, and thence, round the palmar aspect of the finger, on to the dorsum again by a similar route. Having seen that these cuts are down to the bone, he dissects back to the joint; and putting the ligaments on the stretch by bending the finger as required, he divides them, and removes the finger.

Fig. 41.—Amputation of Fingers.

Professor Chiene, instead of carrying the oblique cut quite to the web, when half-way towards it carries the knife down the side of the first phalanx to the first joint. Then, cutting across the palmar aspect of the finger, he returns the knife in a similar way, thus, cutting, from the first phalanx, a square palmar flap of skin, which can be turned up and fitted in without trouble. For the **index** or **little finger**, either method of operation is the same; only, as the web is wanting on one side of each finger, the surgeon must, in shaping his flap, cut it to the point to which the web would have reached had it been present—and not short of this, as he is very apt to do. In the case of the little finger the incision may be carried well on the ulnar side of the fifth metacarpal bone, so that the scar may be out of sight in the usual semi-prone position of the hand. The rules for amputating the thumb are the same as those for amputating any of the fingers. From the usefulness of even small pieces of the thumb, as much of it as possible should always be left.

(b) **Amputation of the Toes.**—In the case of the toes, amputation—except in the case of the great toe—is always performed at the metatarso-phalangeal joint. The oval method is also employed here; but it must be noted that the web is further from its corresponding

joint in the foot than it is in the hand, and, therefore, the straight part of the incision seems to be longer before the turn is taken towards the web.

Any part of the **Great Toe** may be left with advantage, but if the metatarsal bone be removed, the phalanx is useless, and may as well go too.

In amputating at the metatarso-phalangeal joint of the great toe, it is well to carry the inner incision as far as the end of the first phalanx, to ensure a sufficient covering for the massive head of the metatarsal.

(3) **In-growing toe-nail** is the term given to a condition in which, from the wearing of tight boots, a minute foul irritable ulcer forms beneath the outer margin of the nail of the great toe. There is usually considerable local inflammation, resulting in exuberant granulations which overlap the nail, and the unfortunate sufferer is disabled from walking. In treating this painful affection, it is rarely (if ever) necessary to split the nail and remove the offending portion. In place of such a severe procedure, it is only requisite to thoroughly wash the toe with carbolic lotion 1 to 20, and pack under the nail over the ulcer with a pointed piece of wood two or three long fibres of lint soaked in an antiseptic. Over all secure with thread a layer of moist lint, covered with guttapercha. Renew this dressing daily, paying particular attention to the packing. After a couple of days, the guttapercha may generally be omitted, and finally, only the packing retained. The patient had better lie up at first in bad cases, and must discard his tight boots.

(4) **Tapping a Hydrocele.**—The patient usually stands before the operator, who, for convenience, sits on a chair. The operator begins by recognising by the touch and by the sensations of the patient the position of the testicle, which, though usually behind and below the fluid swelling, may occasionally be found elsewhere. He then grasps the swelling with his left hand, and holding the testicle out of the way, causes the fluid part to bulge forward between his fingers and his thumb; then, holding the trochar and canula in his right hand, he plunges it straight through the skin into the hydrocele. In so doing he avoids any visible vein, and selects a spot below the middle of the swelling. To avoid the risk of passing between the skin and the hydrocele sac, the plunge is made perpendicular to both, but at a place where the fluid separates the testicle from the sac sufficiently to allow the trochar to enter without injuring the testicle. The trochar is then withdrawn, leaving the canula just within the sac, while the surgeon's left hand keeps up steady pressure on its contents. Where no injection of the sac is contemplated, as soon as the fluid has all escaped, the canula is withdrawn, and the aperture covered with collodion. When the sac is to be injected, a syringe fitting the canula is charged with the desired fluid, which is then injected after the contents of the sac have escaped. After removing the canula, the injected fluid is left in the sac, and must finally be distributed over its interior by grasping the scrotum at the point of puncture, and rapidly shaking it for a few seconds.

Of the many fluids advocated, 1 to 2 drms. of the Edinburgh tincture of iodine has, perhaps, found most favour. In simple cases of hydrocele, this fluid seldom fails to cure. It causes considerable pain and swelling, however, so that the patient must be kept in bed for three or four days after the operation. The pain will be much diminished if a drachm of a 1 per cent. solution of cocaine (1 grain to 110 minims) be injected into the empty sac about ten minutes before the iodine. The swelling gradually diminishes till it disappears.

Carbolic acid has been recommended as a substitute for iodine, and its use is said to have the following advantages over that of iodine—less pain; more certain cure; less risk of sloughing; shorter period of disability from work.

About a drachm of the crystals is liquefied by as much glycerine (or water) as is just necessary for the purpose. The mode of procedure is the same as when iodine is employed.

Many other fluids have been advocated, and their use has been attended by greater or less success.

(5) **Paracentesis Abdominis** may be required for extreme ascitic distention; the point selected should be in the linea alba 3 or 4 inches above the pubes. The bladder should be empty at the time of the operation. Usually, the patient is supported into the sitting position. To prevent distention of the abdominal veins by the too rapid relief of abdominal pressure, it is well to pass round the abdomen of the patient a broad flannel bandage, which is split in the middle for one end to pass through; the two ends are then drawn upon by an assistant at each side, and the loop round the patient is thus steadily tightened as the fluid escapes.

The danger of syncope from too rapid relief of abdominal pressure, applies equally in large psoas or other intra-abdominal abscesses; where either the evacuation should be partial at first, or compensating abdominal support should be ensured.

A medium-sized trochar and canula should be selected. The surgeon having satisfied himself by percussion that there is no bowel in the way, enters the instrument, and, on withdrawing the trochar, catches the fluid in a vessel held ready to receive it.

A very convenient and gradual mode of withdrawing ascitic fluid is by means of a Southey's tube. One of these, with its tube attached, is inserted into the linea alba, and left there for several hours, until a sufficient escape has taken place.

(6) **Paracentesis Thoracis** may be required for simple pleuritic effusions, when very large, and persistent, or for those of any size which have turned purulent.

As the inspiratory movements of the chest are apt to draw air and with it organisms into the pleural cavity, an ordinary trochar should not be used. For diagnostic purposes a hypodermic needle may be pushed into the pleural cavity, and the syringe filled with the fluid; but when fluid has to be drawn off in quantity, some form of aspirator must be used, *i.e.*, either with an exhausted bottle or with a syphon tube attached.

The part of the chest usually selected is about the level of the angle of the scapula in the mid-axillary line. To avoid the intercostal vessels, the surgeon (where there is room for choice) selects the *lower* part of the intercostal space.

Local anæsthesia by freezing or by injection of novocaine is advisable (p. 26).

In the use of the Aspirator the following points must be attended to:—

(*a*) That, to ensure a clear passage, immediately before and after use, the whole apparatus is run through with boiled water; and that, before use, the needles and canulæ are boiled or steeped in 1 to 20 carbolic lotion for ten or fifteen minutes. Take care also that the place of puncture, and operator's fingers, are thoroughly cleansed and purified.

(*b*) That the exhausting and not the filling end of the syringe is attached to the bottle, when preparing it for use. (The exhausting nozzle is generally lateral.)

(*c*) That the connection between the exhausted bottle and the canula in the abscess or other cavity is not opened until the needle or trochar is withdrawn, and its own stopcock closed.

(*d*) That on withdrawing the canula, the point where it has entered the skin is closed by having had previously laid upon it a piece of wool saturated in collodion.

Note.—The patient should be recumbent. A stimulant should be at hand when the aspirator is used.

(7) **Air in Veins** by the aspiration of the chest is a possible complication of operations on the neck and axilla, when the mouths of wounded veins remain open. The danger is due to the air getting churned up in the right auricle and ventricle, and obstructing the pulmonary circulation, thus causing dyspnœa and, if in insufficient quantity, death. A minute quantity of air in the veins is harmless. The surgeon may be always warned of the accident by the peculiar sucking sound produced.

Treatment consists in instantly putting a wet sponge over the wound, squeezing the chest to expel air already entered, and on cautiously removing the sponge to secure the open mouth of the vein (*Treves*).

(8) **Circumcision**, if for tight prepuce in children (or adults) is performed as follows:—When the child is anæsthetised, put a tight band round the penis and seize the exact *orifice* of the prepuce with catch forceps, and draw it away from the glans. Grasp the tissues in front of the glans with a pair of dressing forceps, and with a knife or scissors cut off the ring of skin which lies in front of the forceps. The outer layer of skin will now retract—the inner layer (sometimes called mucous membrane) next the glans must now be carefully separated with a probe from the glans and turned back so as to expose it. This layer will probably require to be slit up at the upper side (opposite the frænum) and may be trimmed with scissors. The surgeon having thus seen that the glans is thoroughly exposed as far

as the corona, looks for and ties any cut vessels that he can see, then stitches with catgut the outer and the reflected portions of the prepuce, and applies a dressing of collodion or Friar's balsam and wool before allowing the blood to return. When this dressing is removed at the end of a week, the part is generally healed. Circumcision in adults may sometimes be required in consequence of venereal disease, where inflammatory phymosis may have rendered the cleansing and other treatment of sores under the prepuce impossible. When the prepuce is inflamed and where palliative treatment has failed or would take too long, the circumcision should be performed as follows:—Instead of grasping and drawing forward the prepuce, the surgeon must begin by inserting a director between the glans penis and the upper part of the prepuce; with a sharp-pointed curved bistoury, he then slits up both layers of the prepuce as far as the corona. Each half of the prepuce is then grasped with catch forceps and held away from the glans, while the surgeon trims the superfluous prepuce (both layers) with scissors—leaving a margin all round and not touching the frænum. As the parts are generally vascular, allow blood to return, and tie all bleeding points before stitching up. Powder with iodoform, and dress with strips of dry boric lint. Change dressing on second or third day, or at a later date if possible.

(9) **Phymosis**—*i.e.*, where the prepuce cannot be drawn back over the glans penis, may be congenital, or acquired from venereal inflammation. In slight non-inflammatory conditions, the prepuce may be gradually stretched by being drawn back daily. In more severe cases circumcision will be required.

(10) **Paraphymosis** is where the prepuce, after having been drawn behind the glans, cannot be restored to its natural position. The narrow orifice of the prepuce becomes a tight constriction behind the glans, which in turn swells, and so aggravates the mischief. If the condition be not relieved in time, there is a risk of sloughing of the glans, as well as of the prepuce at the point of constriction.

Treatment.—Oil the glans, and try to reduce by grasping the skin of the penis between the fore and middle fingers of each hand, while with the thumbs the glans is pressed back. Should this fail, or should there be much œdema, wrap the glans penis and prepuce in cotton wool, and then compress it with a narrow elastic bandage for twenty minutes, taking care that the elastic bandage extends no further back than the point of constriction. This drives the serous effusion back into the body of the penis, and facilitates reduction, partly by thus diminishing the size of the glans penis, but still more by freeing the reflected part of the prepuce of serum, and so enabling it to double forward over the glans. A second attempt to reduce may now be made, followed by a repetition of the elastic pressure, if need be.

Another method is to grasp the glans with the tips of the thumb and next two fingers, and thus draw on the penis, then with the fingers of the other hand to try to slide the prepuce over the glans.

Should these manipulations fail the constricting parts must be incised.

CHAPTER XII.

ON BANDAGING.

Contents.—Uses of Bandaging—The Roller Bandage—Rules for Bandaging—Typical Cases: How to Bandage (*a*) the Foot; (*b*) the Hand—Cautions to be observed in Bandaging—The "Spica" Bandage for (1) the Heel—(2) Knee-joint—(3) Elbow—(4) Groin ("Ascending" Spica); for Femoral Hernia ("Descending" Spica)—(5) Shoulder—(6) Double Spica of the Groin—(7-8) Single and Double of the Mamma—(9) The Head (how to cover (*a*) the Forepart; (*b*) the Posterior Segment; (*c*) the whole Scalp)—(10) How to Bandage a Stump; the Fingers.

THE bandage is one of the most ancient forms of surgical apparatus, the simplest and most convenient. It is employed under varying circumstances and for many purposes, but its chief use is to give rest and support. With it one may retain splints and dressings, prevent and cure swelling, or check bleeding. Impregnated with some stiffening agent such as plaster of Paris, it gives a rigid material most useful in the treatment of fractures and of other lesions.

Simplest Form of Bandage.—Inasmuch as the proper application of a bandage requires an appreciation of certain *principles* necessary to attain the end in view, it is well to study the most elementary and fundamental form at length; this is the roller-bandage. It is intended in what follows that the student should apply the bandage as he reads, and carry out all the manipulations as they are described.

The Roller-bandage, as provided in hospital, is usually made as follows:—Procure 6 yards of calico, about 1 yard in width, and remove the selvedges. Mark off with scissors short strips of the desired breadth; then grasp the alternate strips gathered in two separate bunches, and pull in opposite directions. From such a web one may thus obtain—

16 rollers,	2½	inches broad;	suitable for the	head and upper limbs.
12 ,,	3	,,	,,	lower limbs.
8 ,,	4	,,	,,	trunk.

These are frequently known as eights, twelves, and sixteens. The strips must now be rolled. Start at one end as if making a cigarette with the fingers and thumb. Lay the small roll on a flat surface, such as a table, or on the thigh; steady the loose strip with the left hand; press the right palm firmly against the roll and run it down over the strip, which will coil round, and we get a firm uniformly wound bandage. Or, again, the small initial roll may be held between

the forefinger and thumb of each hand, and rolled with the fingers as shown in Fig. 42.

In using a winding machine (Fig. 43), care must be taken that the first few turns on the central pin are not very tight, so that when the bandage has been rolled, by grasping it firmly and reversing the handle once or twice, the pin is freed and may readily be withdrawn.

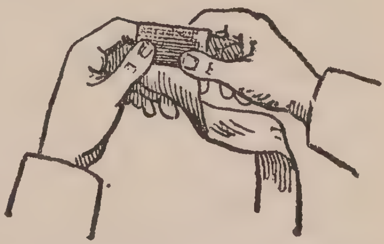


Fig. 42.—Rolling the Bandage.

To finish off the bandage, a few stray threads from the margin may be wound around the roll to keep it together, and the frayed edges trimmed.

To apply the bandage, select the size required, break the encircling threads, and liberate the free end or "tail." The compact roll is known as the "head," and we may further recognise an anterior and posterior surface, an upper and a lower margin.

We may now look at the surface which we are about to bandage. Note that it is always curvilinear. It may be resolved into a series of cones, with bases or apices opposed, with here and there perhaps a short cylinder. In the lower limb, for example, we may trace a cone as we pass from the toes to the heel, another from the heel to the ankle; at the ankle, we may meet with a short cylinder, which is continued upwards as a cone, gradually expanding at the calf of the leg; and so on.

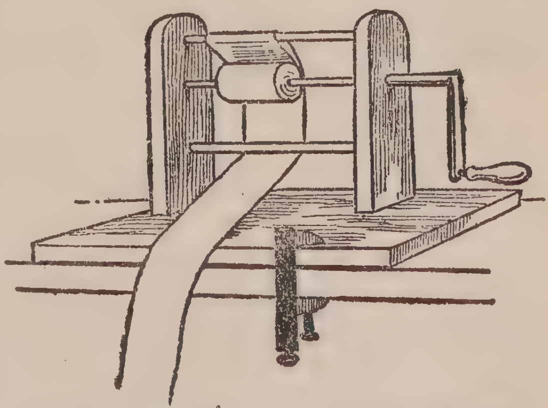


Fig. 43.—Machine for Rolling Bandages.

Rules for Bandaging.—General rules to guide one in bandaging may be laid down as follows :—

(1) Fix the bandage.

(2) Bandage from below upwards, and from within outwards, over the *front* of the limb.

(3) Use equal pressure throughout.

(4) Let each succeeding turn overlap two-thirds of its predecessor.

(5) Keep all the margins parallel, and let the crossings and reverses be in one line, and rather towards the outer aspect of the limb.

(6) End by fixing the bandage securely.

Typical Cases—(*a*) How to Bandage the Foot and Leg.—Let us exemplify this by covering in the left leg. Stand in front of the

patient, who extends his foot. Grasping the roller in the right hand, lay the tail against the ball of the great toe. The bandage must now be carried in a loop round the ankle, and back again to the point from which it started (Fig. 44, A). Therefore, let the head roll on the dorsum of the foot to the outer malleolus, behind the ankle to the inner malleolus, across the dorsum and the first turn to the ball of the little toe, and beneath the sole to the great toe, thus making a double loop or figure-of-eight, and fixing the end. We now proceed to cover in the limb by taking a complete turn over the dorsum of the foot at the roots of the toes, ascending on the inside with a gentle spiral. We cannot, however, continue this simple spiral, otherwise the bandage would stray and portions of the foot would remain uncovered. The spiral is not suitable for cones, and in order to atone, as it were, for the increasing diameter, since our bandage is of uniform breadth, it is necessary to employ a reverse (Fig. 44, B). To make a reverse, hold the head lightly in the right hand—we may note that the *anterior* surface of the bandage is at present exposed—free about

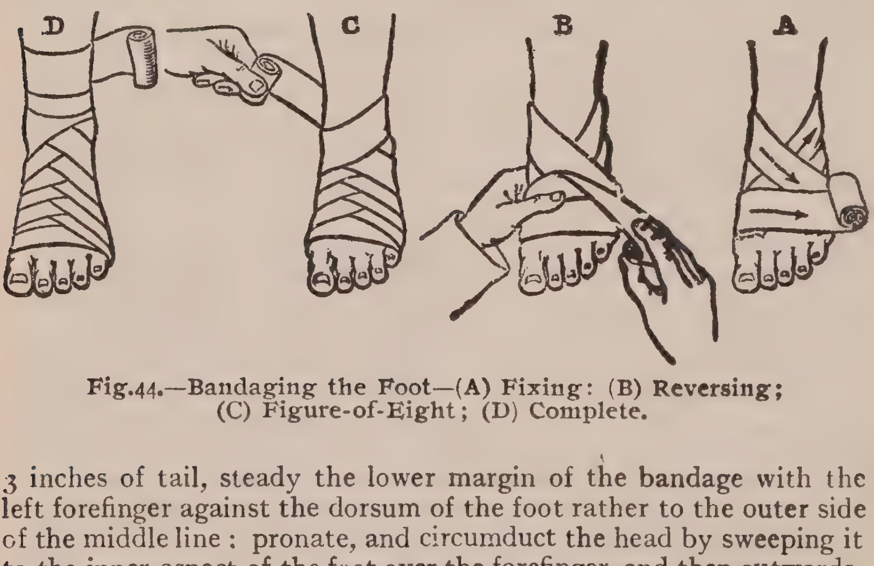
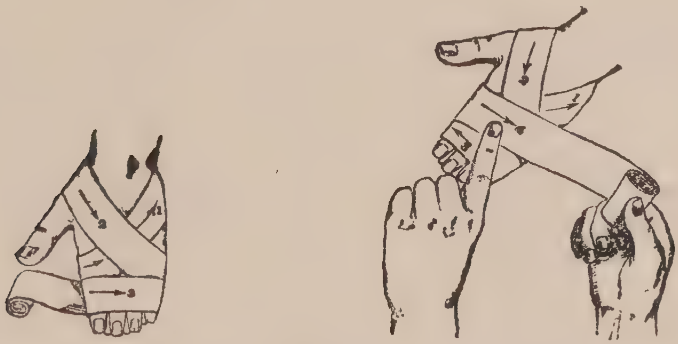


Fig. 44.—Bandaging the Foot—(A) Fixing: (B) Reversing; (C) Figure-of-Eight; (D) Complete.

3 inches of tail, steady the lower margin of the bandage with the left forefinger against the dorsum of the foot rather to the outer side of the middle line: pronate, and circumduct the head by sweeping it to the inner aspect of the foot over the forefinger, and then outwards, so that a fold forms. The *posterior* surface of the bandage is now exposed, the upper margin points to the toes, and the head no longer rolls on the foot, but requires to be unwound, as we carry the roller under the sole upwards with a gentle spiral ascent. As the bandage passes from the outside to the inside of the limb, it is received by the left hand, and transferred again to the right hand. The bandage now reaches the point of the former reverse, but at a higher level, overlapping two-thirds of the last turn, and a second reverse is required. Again we repeat our former manœuvre, fixing the margin in the same line as our previous fold. We may note that now we bring the *anterior* aspect of the roller into view, and the bandage again rolls. In this way, we make two or three reverses, alternately

rolling and unwinding the bandage, exposing alternately its anterior and posterior surfaces. As we mount the instep, however, it will be found that the bandage no longer lies smoothly, that is because we approach the junction of two cones at the heel, and wherever that occurs the figure-of-eight is required (Fig. 44, C). In place of reversing, we pass round the outer malleolus, and so come down from behind the inner malleolus, over the dorsum, under the sole, ascend on the inner side, cross the dorsum, and so back to the internal malleolus. This is repeated until such time as we reach the ankle, when, as we now meet a simple cylinder, two or three spirals are available before the bandage is pinned off (Fig. 44, D), or secured by splitting the tail and passing the ends in different directions before tying them together.

Bandage of the Leg.—If it be desired to bandage the calf of the leg, two methods are available. One is to continue the foot bandage up the calf, making reverses downwards till the thickest part is reached, then reverses upwards till the narrowest part below the knee



a *b*

Fig. 45.—Bandaging the Hand: ***a*, Fixing; *b*, Reversing.**

is reached, when the bandage is finished with one or two circular turns before being pinned off. The series of reverses should run up the anterior and outer part of the leg, so as to lie over muscle and not over the shin surface of the tibia. This method makes a very neat bandage, but is not so serviceable as the other method—*i.e.*, figure-of-eight for the calf of leg, which will be described later (p. 135).

We may here observe that the simple *spiral* is used in the case of cylinders, the *reverse* when covering cones, and the *figure-of-eight* at the basal junction of cones.

Typical Cases—(*b*) How to Bandage the Hand.—Just as we bandaged the lower extremity, so may we bandage the upper. The arm should be extended and prone, so that the palmar aspect of the hand occupies a position similar to the plantar of the foot. Small oblong pads of dry cotton wool (preferably charged with some non-irritating antiseptic) are laid between the fingers so that the skin secretions may be absorbed. It is of cardinal importance that the

skin surfaces should always be kept apart, or else chafing will certainly ensue.

The hand now corresponds to the			foot.
The forefinger	,,	,,	great toe
The little finger	,,	,,	little toe.
The wrist	,,	,,	ankle.
The thumb	,,	,,	heel

The initial figure-of-eight turn for fixation is made by laying the tail of the bandage under the second phalanx of the forefinger, looping round the wrist, descending to the terminal phalanx of the little finger, and so on in every respect just as we bandaged the foot. As the heel was left exposed, so also do we leave the thumb free.

In bandaging the left limbs, our manipulations are chiefly carried out with the right hand; but in the case of the right limb the left hand is employed, a task which, at first somewhat awkward to accomplish, becomes easy with practice.

a *b*

Fig. 46.—Bandaging the Closed Fist: *a*, **Figure-of-eight Loops;** *b*, **Finishing.**

Cautions!—It is of the utmost importance that there should never be any constriction of the limb. The bandage should exert uniform pressure with ease and comfort to the patient. It is necessary to increase the tension somewhat with the circumference of the limb, In any case, the condition of the exposed digits affords a sure guide to the state of the circulation. In children especially, the utmost care is requisite, for their soft tissues yield readily and with a moderate amount of force constriction may be caused, the circulation impeded, and gangrene, as the result of tight and careless bandaging, ensue. The slightest œdema or discoloration is a warning, which we dare not neglect.

B. Special Forms of Bandage: The Spica.

This is simply a figure-of-eight, and the term "spica" refers to the cross-like arrangement seen at the intersections of the figure-of-eight, which bear a certain resemblance to the arrangement of glumes

in a spikelet of wheat. (From the Lat. *spica*, an ear or spike of corn.) The terms ascending and descending spica are employed according to the manner in which the successive turns mount or descend upon the limb. Any spica may be made either ascending or descending, according as the first crossing point is at the highest or lowest portion of the part to be covered.

In order to cover in large prominences, such as the heel, the bent knee, and elbow, a modification of the figure-of-eight, known as the "Divergent Spica," is made use of.

(1) *Divergent Spica for the Heel.*—Lay the tail against the external malleolus, and carry the roller under the sole to the internal malleolus, and thence from within outwards over the dorsum to the point from which you started, thus fixing the bandage Now travel over the tip of the heel, so that its most projecting part is embraced by the tense middle portion of the turn, and the two margins are left loose. Pass over the dorsum and again round the heel, diverging from the tip so as to fix the lower loose margin ; the next turn, passing round the heel at a higher level, includes the upper loose margin. In this

a *b*

Fig. 47.—Divergent Spica of the Heel.

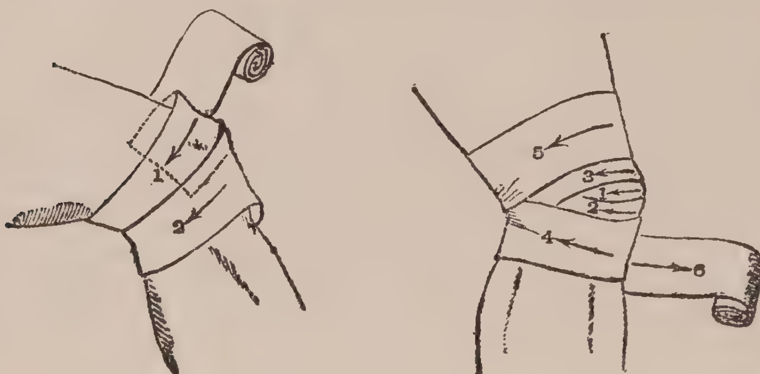
way the middle third of the first turn over the heel is exposed, and the succeeding turns confine and overlap the loose margins of their predecessors. The bandage may be carried over the forepart of the foot and up the leg, if necessary. Such a bandage serves to retain dressings, etc., but is not frequently required.

(2) *Divergent Spica of the Knee-Joint* (Fig. 48).—The limb must be slightly flexed.

Lay the tail against the inner condyle. Pass the roller over the front of the patella and outer condyle back to the starting point. The second turn travels in a similar direction, but at a lower level, so that the lower loose margin of the first turn is fixed, and in a similar way the third turn secures the upper loose margin. A transverse elliptical series of margins, which imbricate, are thus seen in front of the knee-joint, and a limited range of movement is allowed, as the layers glide easily on each other like scale-armour as the limb swings to and fro. Such a bandage may be useful in giving support to a joint which has been inflamed. It specially protects the posterior and lateral aspects of the joint ; the anterior does not require such covering owing to the pastella. In the case of varicose veins, an ordinary

bandage carried from below upwards, and over the knee, will allow the patient to walk freely, if the divergent spica be employed.

(3) *Divergent Spica of the Elbow* differs in no respect from that of the knee. It is employed in cases where we keep the arm at rest in the flexed position, as after fractures and injuries to the joint.



a *b*

Fig. 48.—Divergent Spica of the Knee-Joint.

(4) *Spica of the Groin*—(*a*) *Suitable for Inguinal Hernia.*—To form the first loop (Fig. 49), lay the tail over the external abdominal ring of the ruptured side, and carry the roller upwards and outwards around the pelvis, midway between the great trochanter and the crest of the ilium back to the starting point, where it crosses the tail. To form the second loop carry the bandage over the outer aspect of the thigh round into the perinæum, and back to the starting point again. In this way a series of crossings is produced, each higher than the preceding one, with which we may exert pressure all along the line of the inguinal canal. Beneath each crossing a small flat compress of lint may be laid so as to afford sufficient pressure.

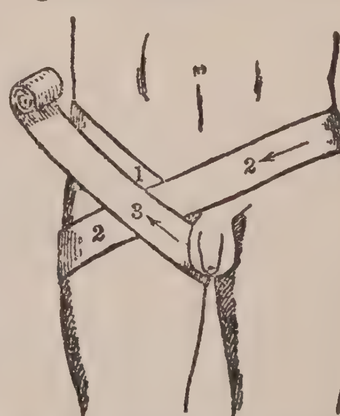


Fig. 49.—Spica of the Groin—Ascending Form.

(*b*) *For Femoral Hernia* (Fig. 50).—Lay the tail over the saphenous opening, and carry the roller over the symphysis and round the pelvis at the same level as before. As the first loop is completed, the bandage is next passed downwards into the perinæum and outwards round the thigh back to the starting point; thus the second loop is finished, and the succeeding turns follow in the same manner, each lower than the preceding one. It will be observed that, as regards the successive crossings, the line of support in each case agrees with the

direction of taxis used in reducing the hernia, viz., from below upwards, in the first case—from above downwards, in the second.

(5) *Spica of the Shoulder* is practically the continuation upwards of the bandage of the upper extremity. The larger loop of the figure-of-eight is formed by passing from the highest limit of the upper arm over the shoulder and behind the chest, under the opposite axilla, and back again over the shoulder. As the smaller loop is formed by carrying a turn round the arm, the crossing takes place in the line of the last reversal. In this manner, by continued overlapping turns, the whole shoulder may be covered in. We do not carry the bandage around the neck, since it is so freely movable; but we select the chest instead, much in the same way as we take the fixed pelvis when applying the spica of the groin, in preference to the mobile abdomen. Just as the rise and fall of the abdominal parietes would vary the tension of the bandage, so also would the movements of the

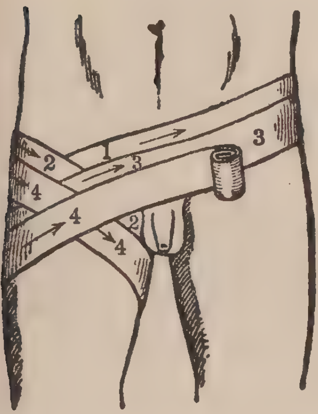


Fig. 50.—Spica of the Groin—Descending Form.

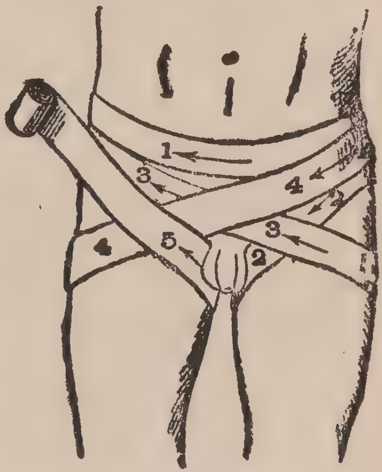


Fig. 51.—Double Spica of the Groin.

neck relax or tighten the figures-of-eight, and the bandage would not be secure.

(6) *Double Spica of the Groin* is of little practical importance, but is sometimes used to retain dressings. The diagram (Fig. 51) explains itself. There are three crossings produced, one at each groin, and one in the middle line. This bandage might be used in cases where there was an *inguinal hernia* on one side, a *femoral* on the other. For double herniæ of the *same* kind, it is better to apply a separate single roller to each.

(7) *Single Spica of the Mamma* (Left).—Lay the tail against the left side, and take a complete circle round the anterior aspect of the waist, travelling towards the mammæ, so that the roller confines the tail. Support the left breast gently with one hand, while with the other carry the bandage from below upwards; withdrawing the hand, the bandage takes its place, and the second loop is completed

as the roller travels to the right shoulder, and obliquely over the back to the point from which the ascending loop started. A series of such figures-of-eight may be superimposed as required (Fig. 52).

(8) *Double Spica of the Mamma,* may be compared with the double spica of the groin. The one breast is supported from below upwards, the other from above downwards, just as in the two forms of hernia. Where both mammæ are inflamed, separate bandages for each are more useful (Fig. 53).

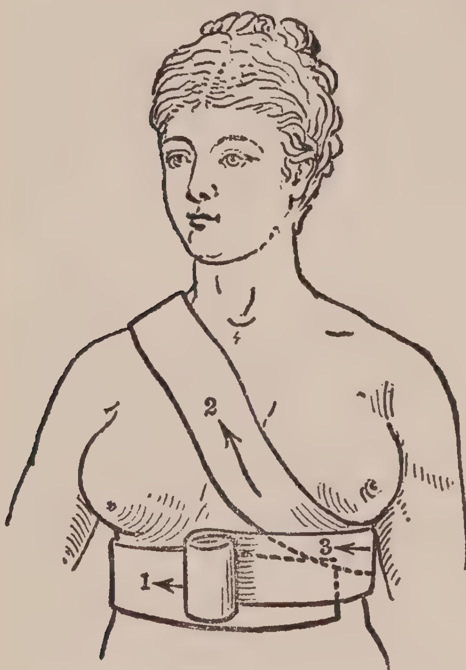


Fig. 52.—Bandage for Left Mamma, begun.

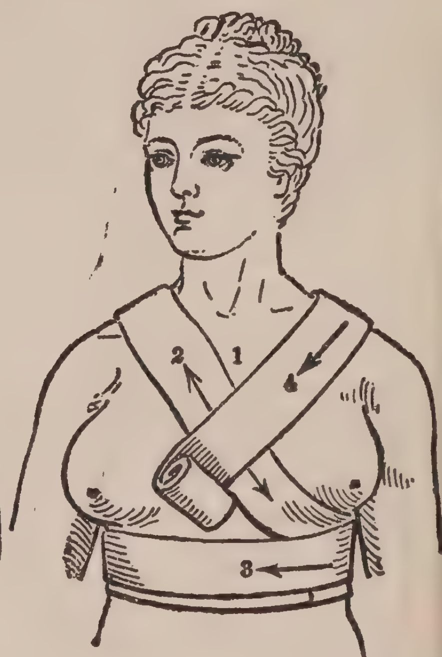


Fig. 53.—Double Spica for Left Mamma.

(9) **How to Bandage the Head.**—The divergent spica is the typical bandage for the head. Owing to the tendency of the figure-of-eight loops to slip on this part of the body, it is important that the initial and concluding turns should be secure, and that all should have a mutual dependence. Three main series of loops, at right angles to each other, are employed. (1) *One, horizontal* in direction, passing above the level of the ears, grips the cranium firmly (Fig. 54) between the frontal eminences and superciliary ridges anteriorly, and below the occipital protuberance posteriorly. (2) *A second series, coronal,* runs from the vertex below the chin, passing behind and sometimes in front of the ears. *A third final turn* courses over the vertex *from behind* forwards. At the various crossings, pins should be inserted, or all may be basted together with a needle and thread.

To cover in the Fore Part of the Head, proceed as follows :—Grasp the loose tail in one hand, and carry the roller around the head to

form the horizontal turn. Pass the roller beneath the loose end, carry it at right angles to the first turn, and so form the coronal circle. The scalp is thus divided into an anterior and a posterior segment; one may, therefore, cover each of the exposed portions with a separate divergent spica, making use of the loose tail as a fixed

Fig. 54.—Knotted Bandage of the Head—beginning.

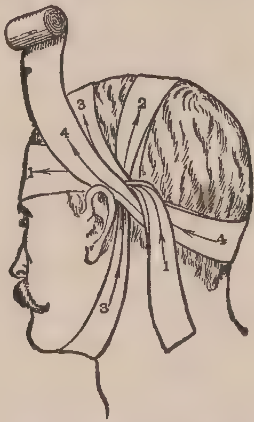


Fig. 55.—Formation of Divergent Spica over Anterior Part of Head.

point, around which our successive turns play, as seen in the diagram (Fig. 55). Finally, by carrying the bandage from behind forwards we complete all; for to this concluding turn the others are all pinned, and so secured.

The posterior half of the scalp is more difficult to cover in. By

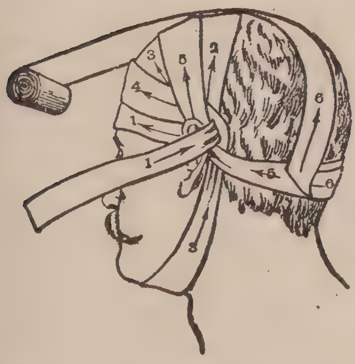


Fig. 56.—Postero-Anterior Turn—Conclusion of Knotted Bandage.

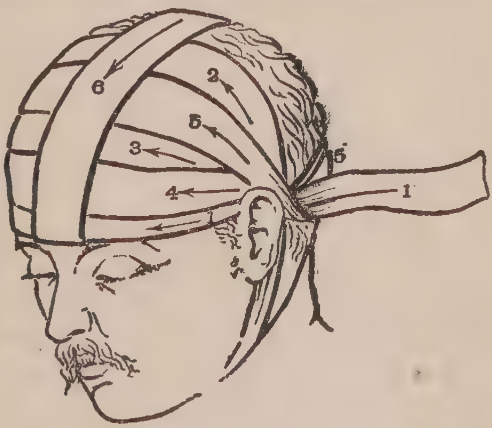


Fig. 57.—Complete Knotted Bandage.

giving an increased obliquity to some of the loops, by carrying the turns around the forehead, under the chin, and, perhaps in front of the ears—according to the individual peculiarities of the head in question—a good result may be obtained. We may proceed also in a somewhat similar way without the loose tail, and keep the bandage

flat throughout. A series of figure-of-eight turns, horizontal and oblique in direction, as shown in Figs. 58 and 59, are employed. It will be noted that the vertical turns loop in front of and behind the respective ears. Should the shape of the skull prevent the applica-

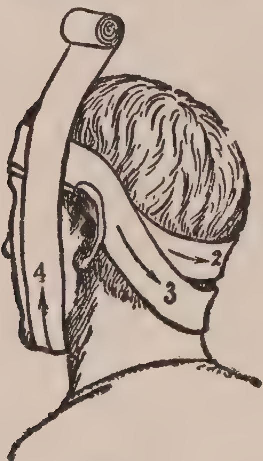


Fig. 58.

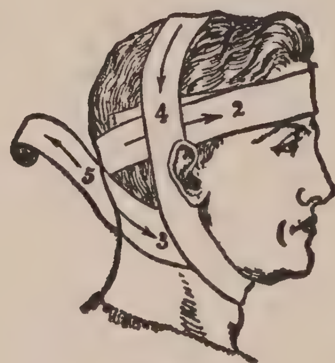


Fig. 59.

tion of such a bandage, or if it be desirable to cover in the whole scalp, the *capeline bandage or double-headed roller* may be used as follows :—

Fig. 60.—Beginning the Capeline Bandage, viewed from behind.

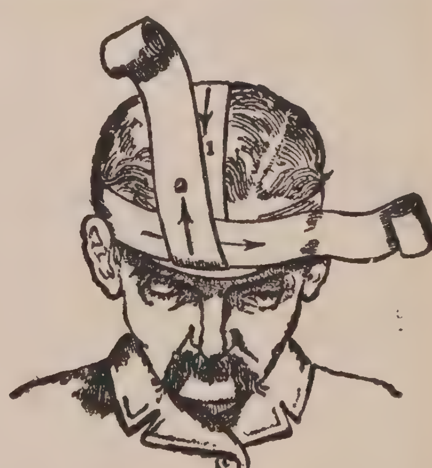


Fig. 61.—Capeline Bandage, from the front.

To cover in the whole Scalp.—Fasten two rollers together as shown in Fig. 60. Let one be rather longer than the other. The larger roll should always circle round the head, the smaller should after the first turn travel backwards and forwards. The horizontal turns serve

to fix the vertical, which form a divergent spica. Stand behind the patient with the larger roller in the left hand, the smaller in the right. Lay the bandage against the root of the nose, and carry the rollers horizontally directly backwards. Change hands at the occiput, and let the horizontal turn cover the vertical one, which should now be carried forwards right over the nose, at the root of which it is fixed by the circling horizontal turn. The vertical turn is now carried back again to the occiput, slightly to one side of the middle line, and is once more fixed posteriorly by the horizontal turn—and so on. Care must be taken not to diverge too rapidly, and to come well down to the glabella in front and below the occiput behind at every turn. In this way, a most firm and secure bandage is obtained, which defies every attempt to take it down. It is, however, somewhat heating, and the superimposed circling turns are rather constricting, and apt to induce headache. Gauze bandages do not give rise to this objection.

The divergent spica may be used for the head with a *single* roller, if one have assistance. A couple of horizontal turns to fix the bandage are made. The roller then passes at right angles from occiput to glabella, and at each angle is fixed by the assistant's fingers, which must be firmly applied, and which will serve to confine the extremities of each turn of the divergent spica. Finally, a concluding couple of turns replace the fingers, secure the ends of the bandage of the vault, and safety-pins, transfixing all the folds, are inserted in front and behind.

Fig. 62.—Bandaging the Eye.

(10) *How to Bandage a Stump.*—In a similar way, one may bandage a *stump*. Here the thumb and fingers serve to grasp the ends of the divergent spica, which passes over the face of the stump. Final circular turns and pins hold all together.

How to Bandage the Fingers.—As a rule, the digits receive sufficient support with the ordinary bandage for the hand. Small dressings may be secured with a few turns of worsted. If thought necessary, a narrow bandage for the prevention of œdema is put on by taking a turn around the wrist, passing to the tip of the finger in question, gently spiraling to the web, and so back to the wrist. One may also go from finger to finger, taking a turn round the wrist between each. For the thumb, a figure-of-eight is desirable.

CHAPTER XIII.

BANDAGING (*Continued*).

Contents.—Looped Bandages—(1) For the Heel—(2) For the Calf of the Leg; Varicose Veins—(3) Bandage for use after Excision of the Breast—(4) For the Perinæum—"Lithotomy" Position—The "Clove Hitch": How to make it—The T-Bandage—The Four-Tailed—The Many-Tailed Bandage—The Triangular Handkerchief—The Square Handkerchief—The Suspensory Bandage, etc.

Looped Bandages.

(1) THE *Looped Bandage* is used in many parts of the body, and the student will always remember it if he grasps the general principle. This may be stated as follows:—"Start from some given point (which generally lies on a cylindrical or grooved surface), loop round some projection and return to the starting point." The bandage on

Fig. 63.—Looped Bandages for the Heel.

its return journey travels in the reverse direction, so that the second loop, when the procedure is repeated, passes over the opposite side of the projection from the first. The third is similar to the first, and the fourth to the second, and so on.

As *applied to the Heel* the details are as follows, and after he has learned them the student should practice this bandage while repeating the general statement of the method:—

Suppose, after some preliminary turns, we start from the front of the instep to loop round the heel; carry the bandage downwards and outwards to the sole then up under the inner malleolus to the tendo Achillis, and so back over the outer malleolus to the starting point (Fig. 63, *a*). Next continue the bandage downwards and inwards to the sole, up under the outer malleolus to the tendo

Achillis, and so back over the inner malleolus to the starting point (Fig. 63, *b*). The point of the heel is not covered by this bandage, but should this be required, we begin with the first turn of a divergent spica (Fig. 47, *b*), and follow on with the looped bandage to secure the loose edges. It will be evident that the direction in which the loops are made is not important—*i.e.*, the arrow shown in Fig. 63, *b*, might have pointed downwards instead of upwards without affecting the general result.

(2) *Figure-of-eight Bandage for the Calf of the Leg.*—This is a very satisfactory bandage for ambulant cases, whether for fixing on dressings or for supporting varicose veins, For varicose veins, a pure rubber or web elastic bandage is best, but an excellent substitute

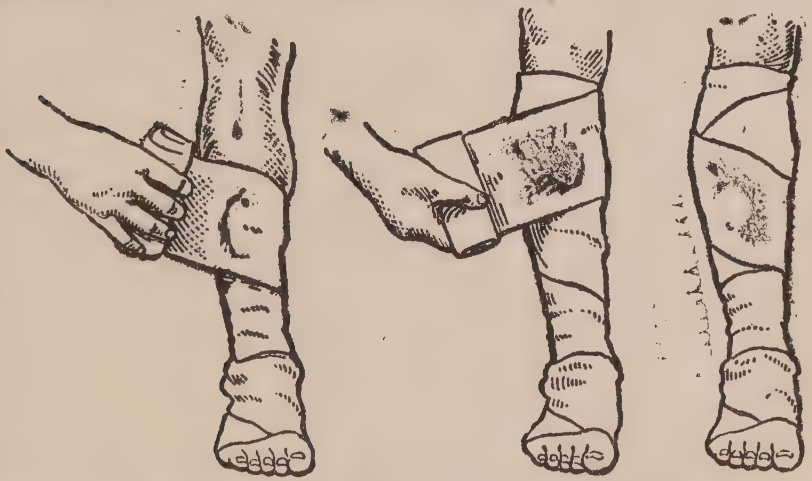


Fig. 64.—Figure-of-eight Bandage for Leg. The figure on the right represents the finished bandage, but does not show several turns which were made after the stage indicated in the middle figure. The bandage was finished behind in this instance.

is found in a domet or crepe bandage 4 to 6 inches wide applied in a figure-of-eight.

Application.—The lower end of the bandage is fixed by one or two turns round the foot (Fig. 44, *c*). Overlapping spiral turns are then carried upwards till the calf begins to thicken. In order that the bandage may be applied evenly to this conical surface, the lower border requires to be drawn upwards more than the upper one. Hence the spiral tends to run up rapidly. A reverse would remedy this; but instead we carry the bandage round the upper part of the calf where the cone tapers in the opposite direction—*i.e.*, upwards. A turn here has the desired effect, and the bandage now winds naturally downwards again, and can be coaxed round the lower cone a little higher than the last turn there. The same process is repeated until the whole calf is covered and the bandage is finished below the knee by pinning or tying (see Fig. 64).

With a little practice the patient can learn to apply this bandage

himself. In Kashmir the natives wear a bandage of this kind as a part of their dress, and varicose veins are almost unknown among them.

(3) *Bandage for dressing after Excision of the Breast* (*Right*).—Apply the dressing, cover the sound breast with antiseptic or sterile wool. Lay the tail of the bandage over the sound breast. If the arm is to be included as some surgeons prefer (Fig. 65), fix the dressing with one or two horizontal turns, then starting at the axilla of the sound side pass the bandage across the front of the chest (3) to the top of the opposite shoulder, then carry it down behind the shoulder to the elbow, and thence obliquely upwards across the front to the starting point (4). Now form the second loop by passing round the back and down the front of the shoulder (5), and so on till the dressing is secure. When the arm is not included, the loops pass in a similar way

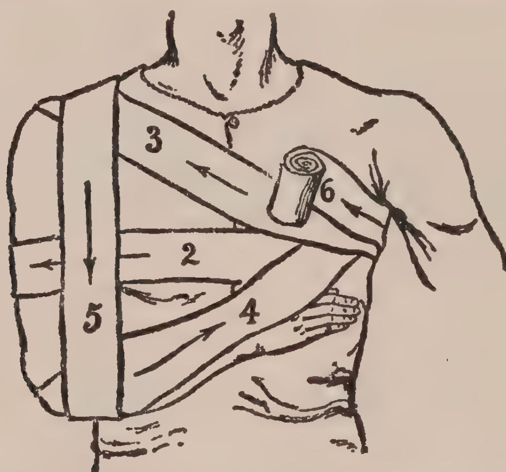


Fig. 65.—Looped Bandage for Arm and Shoulder.

except that they do not include the arm which is abducted during the application of the bandage.

(4) *Looped Bandage for the Perinæum.*—This is used in the application of dressings to the scrotum, etc. Lay the tail midway between the left anterior superior spine and the great trochanter. Sweep round the pelvis at the same level back to the starting point, thus fixing the bandage. Dip down into the perinæum over the left groin; pass in front of the anus, and carry the bandage upwards in the line of the right gluteal fold to the hollow between the right anterior superior spine and great trochanter. Sweep across the front of the pelvis (3) to the starting point. This completes the first loop. Now pass round the back of the pelvis to a starting point on the right side below the anterior superior spine and form a second loop (4 and 5), this time round the left thigh, and so on. In this case the starting point alternates from one side to the other by the bandage passing round the back of the pelvis to the opposite starting point, otherwise the general statement of the looped bandage (p. 134) holds good (Figs. 66, 67, 68).

The "Lithotomy" Position.—For operations on the perinæum, the well-known "lithotomy" position is the most suitable. The patient, laid on his back and deeply under the influence of an anæsthetic, is pulled down on the table till his breech just projects beyond it. A clove-hitch (*see below*) is secured to each wrist, the thighs are flexed on the abdomen, and the legs on the thighs; and now, by seizing the free ends of the clove-hitch, the wrist is brought down to lie

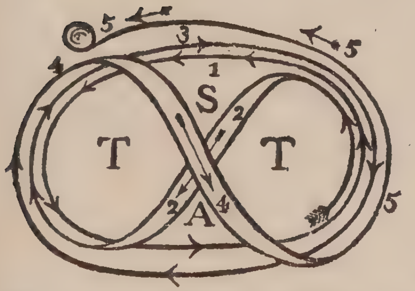


Fig. 66.—Diagram of Looped Bandage of Perinæum seen from below —T, Thighs; S, Scrotal Triangle; A, Anal Triangle.

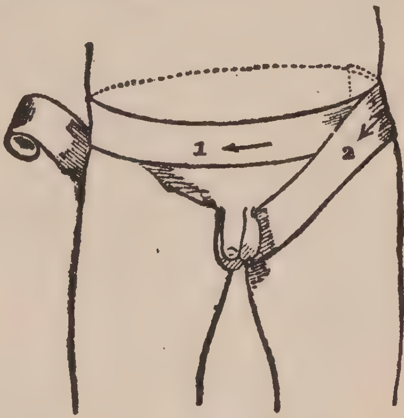


Fig. 67.—Looped Bandage for Perinæum, or St. Andrew's Cross Bandage — First Turns.

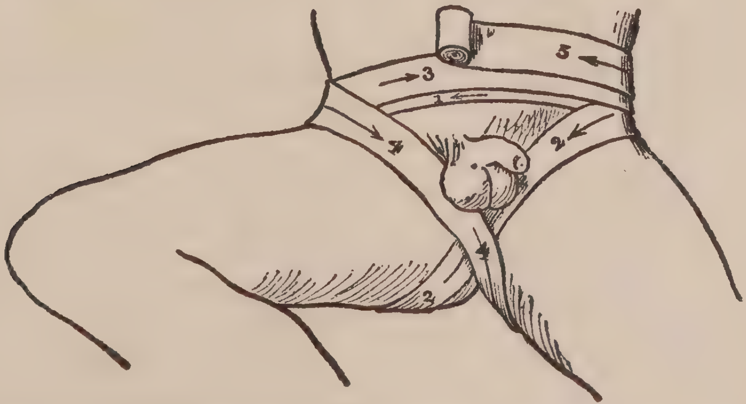


Fig. 68.—Looped Bandage for Perinæum—Crossing of the Loops.

opposite the external malleolus, and secured to the foot by firm figure-of-eight loops, as in Figs. 70, 71. During the operation, care must be taken to maintain the pelvis firm and square, with the thighs in the same position on each side. The assistant secures the legs by holding the sole with both hands, the knee resting in the middle.

The "Clove-Hitch" is made as follows:—Grasp the bandage, etc., with the left hand supine and the right prone, as indicated in the

figure, now pronate and supinate the two hands respectively (Figs. 72, 73), and slide both loops on to the left hand (Fig. 74).

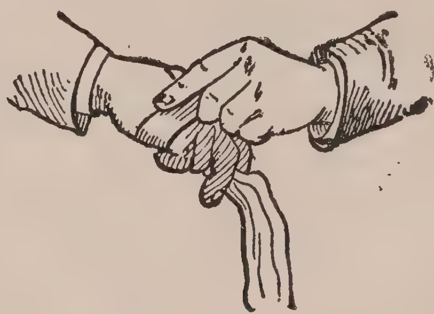


Fig. 69.—Forming Loop for Lithotomy Position.
A substitute for the clove-hitch.

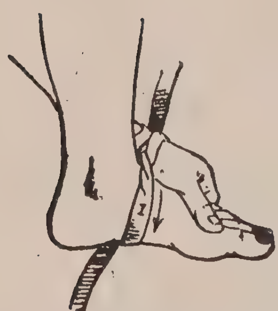


Fig. 70.—Lithotomy Position—Fixing Hand to Foot.

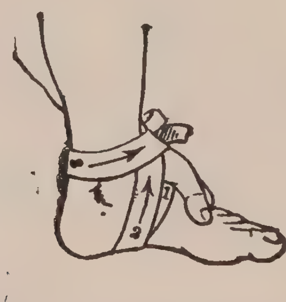
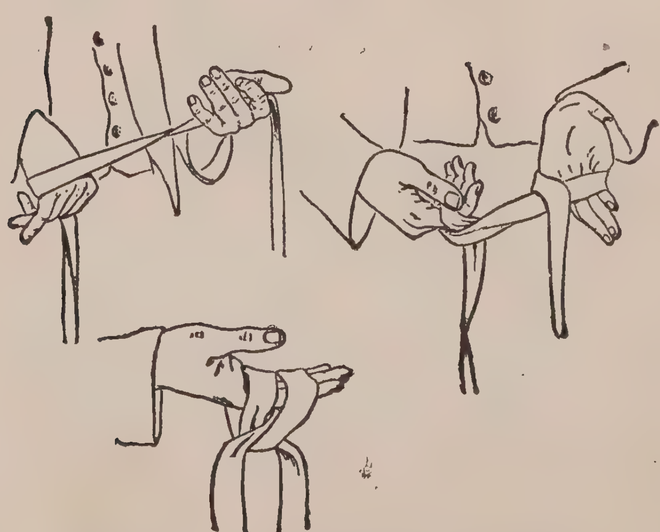


Fig. 71.—Lithotomy Position—Hand and Foot Fixed.



Figs. 72, 73, 74.—Forming the Clove-Hitch.

Another plan is to make too successive loops in the same direction, and place one behind the other.

(5) *The* T-*Bandage* is employed for the perinæum. The horizontal limb passes around the pelvis; the vertical limb—single, double, or split—serves to retain rectal dressings, with the advantage that the split tails may come up on each side of the scrotum.

(6) *The Four-tailed Bandage* is used in the fracture of the lower jaw.

(7) *The Many-tailed Bandage* (or bandage of Scultetus), consists of a central strip or backbone of bandage, to which some eighteen shorter imbricated strips (Fig. 75) are stitched at right angles. The limb is laid on the bandage so that its axis corresponds with the central strip, and beginning at the periphery, the strips are gently and firmly folded over as seen in the diagram. A pin at each side, securing the two last strips to their predecessors, serves to fasten all safely. By taking out the pins, and flinging the tails right and left, the whole bandage is readily taken down, and a fresh dressing having been applied, the strips may once more be folded over so that the

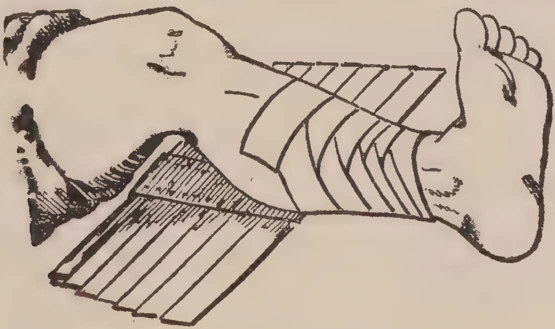


Fig. 75.—Many-Tailed Bandage.

limb need not be disturbed in the least. The bandage is recommended for burns, painful wounds, as also for the abdomen and thorax.

Sister Stenhouse uses the following convenient method of keeping the tails in their relative position before the bandage is applied. The bandage is laid out flat, and a strip of folded paper about an inch wide and of sufficient length is laid across the free ends of the tails, on each side. Round the paper the tails are then folded inwards towards the centre till the two sides meet. In this form the bandage can be conveniently handled.

(8) *The Triangular Handkerchief.*—The use of slings, in place of the bandage, has been revived in recent years. Esmarch of Kiel has especially drawn attention to their use in military surgery. The handkerchief possesses many advantages. It can be speedily and easily applied. It is available for many varied purposes, and is readily washed. In using the sling, the base of the triangle should always be applied to the part which requires support. Thus we see in Figs. 76 and 77 the elbow specially is supported, the tails of the bandage resting on both shoulders, and tied together in a reef knot.

In Fig. 78 while the elbow is supported, the weight of the arm is borne by the opposite shoulder only. In Figs. 79 and 80 the wrist and forearm are specially supported, hence the base of the handkerchief is towards them. In Fig. 79 the bandage rests on both shoulders, while in Fig. 80 it rests on the shoulder of the sound side only.

The manner of applying the bandage illustrated in Fig. 78 is as follows :—

The patient lays the affected arm on his chest with the fingers near the opposite shoulder. The surgeon then lays the triangular handkerchief over the patient's arm with the base over the elbow

a

b

Figs. 76 and 77.—Triangular Handkerchief supporting the Elbow, *a* and *b*.

and forearm, the ends of the bandage meet and are tied over the shoulder on the sound side, one coming from behind, the other from the front. In adjusting the bandage the base is made to pass over the elbow and forearm, while the point is brought round so as to lie between the arm and the chest wall. The point is then gathered up and pinned so as to enclose the injured limb as much as possible. Another way of applying this sling is to keep the point on the outer side and bring the base of the handkerchief round the elbow and forearm, so that it may lie between these parts and the chest wall.

Fig. 83 shows the sling adapted to retain dressings on the head.

Fig. 78.—Triangular Handkerchief supporting the Elbow, *c*.

Fig. 79.—Triangular Handkerchief supporting the Forearm.

Fig. 80.—Triangular Handkerchief supporting the Forearm from the opposite shoulder (*after Esmarch*).

Fig. 81.—Dressing for the Shoulder with Handkerchiefs (*after Esmarch*).

In a similar way, we may cover in the hand or foot. With one handkerchief rolled as a cravat, and applied so as to give a fixed point, a second may serve to secure a dressing, as in Figs. 81 and

Fig. 82.—Dressing the Thigh with Handkerchiefs (*after Esmarch.*).

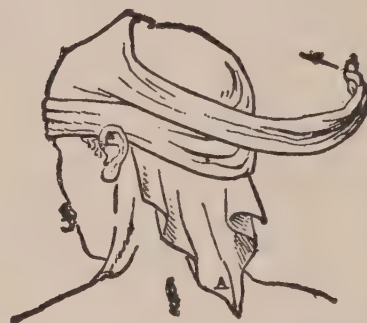


Fig. 83.—Triangular Handkerchief for the Head. The dependant Angle is to be turned up and pinned over the Vertex.

82, where the shoulder and hip are seen covered in. Such examples may suffice.

(9) *The Square Handkerchief.*—A good head-dressing may be formed from a square handkerchief (40 ins. square), folded across 4 inches beyond its middle line, and laid over the head, as represented

Fig. 84.—The Square Handkerchief for the Head.

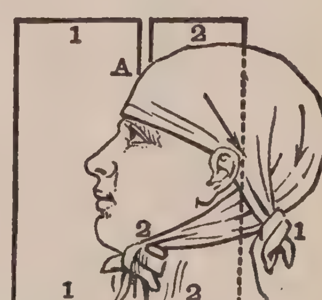


Fig. 85.—Square Handkerchief used for the Head after splitting as at A.

on the left side of Fig. 84. The two *outer* corners (A, A), that is, those of the smaller portion of the napkin, are first carried beneath the inner corners, and tied under the chin. The edge of the inner and larger portion is then turned up over the forehead, and its

corners are secured at the nape of the neck. A four-tailed handkerchief (Fig. 85), and one with six tails, have also been used for a similar purpose.

(10) *Suspensory Bandage.*—This refers to the suspension of the testicles, and may be called for in orchitis and epididymitis, varicocele, or when the skin of the scrotum is ulcerated or eczematous.

An open network bag to hold the testicle, attached to a waist-band, is sold by chemists and instrument-makers. Failing this, an extempore support may be made from a triangular piece of cloth. A waist-band is first applied, and the long ends of the triangular cloth are fixed to it. The straight edge of the cloth is brought under the scrotum, and the point carried over it and fixed above.

A pair of well-fitting bathing-drawers, padded with cotton wool, if necessary, make an excellent suspensory bandage. Some use a T-bandage, the vertical part of which (of broad flannel) is carried from the back up over the scrotum, so as to raise it. An aperture may be cut for the penis to allow of micturition, without the necessity of taking the bandage down.

Strapping the Testis is frequently required to remove swelling after acute orchitis or epididymitis. Some lint, and about a dozen strips of sticking-plaster, ½ inch wide, and long enough to encircle the testis in both directions, are required.

The affected testis is first isolated in the scrotum, by a circle of lint at its upper part, over which is a layer of plaster. The organ cannot now slip away, and it must be covered with successive layers of plaster, longitudinal and circular.

In a few days the swelling by subsiding will have left the plaster loose when it must be applied again.

CHAPTER XIV.

ON FRACTURES.

Contents.—A. Fractures in General—Diagnosis; Importance of knowing the History of an Injury—Examination of the Injury—Treatment; (1) The old Immobilisation Method; (2) By Massage and Early Movement; (3) By Immediate Operation—Scope of these Different Methods; Treatment of Distortion from Muscular Spasm—Setting of the Fracture—Prognosis—Material for Splints—Union—Delayed Union—"Greenstick Fracture"—Dislocation and Fracture, Distinction between.

B. Special Fractures of the Upper Extremity—Treatment of Fracture of the Clavicle; of the Body of the Scapula; of the Humerus; of the Forearm; of the Olecranon; of the Radius above the Wrist (Colles' Fracture); of the Carpals and Metacarpals.

A. Fractures in General.

THERE are comparatively few of the surgical ailments which fall into the hands of the general practitioner of greater importance than **Fractures**. The future usefulness of a fractured limb depends largely on the diagnosis and on the consequent treatment. Moreover, the cases vary so greatly in difficulty, and so much hangs on the result of the first examination, that it is well to study each, no matter how simple, with method and exactness.

Diagnosis.—*Importance of knowing the History of the Injury.*—When a person sustains a fracture, some provisional treatment is usually required and obtained from the by-standers (see Chap xviii).

The surgeon should note carefully the history of the accident. He must ascertain when and how it happened, and should direct special attention to the position of the patient at the time of the injury. It is of importance to know if the limb was used or moved thereafter, and to what extent. People have been known to walk even a considerable distance with one of the bones of the leg broken. We wish to know the nature and amount of force which brought about the fracture, whether the violence was direct or indirect, so that we may be able to form an opinion as to the position and line of the fracture, and of the character of the displacement.

Examination of the Injury.—To follow out a complete examination, have the limbs stripped and exposed. It is a good rule to remove the clothing from the sound limb first, after which the injured limb can be more easily freed. In like manner, when the patient is able to put on his coat or trousers, he should always *begin* with the injured extremity. It is best to cut away the clothing in bad cases. The companion-limb should be laid in a position

similar to that of its injured fellow, and having ascertained whether there has been any former lesion or deformity, both may be compared. A glance may reveal the presence of abnormal elevations, depressions, or the filling up of hollows. Measurements should now be made. For this purpose certain fixed bony points should be selected on each side, and marked with ink. In the case of the leg, we would indicate the anterior-superior iliac spines and the tips of the external or internal malleoli. The surgeon then stretches an inch-tape or bandage from the one point to the other, so that it barely touches the skin; and looking vertically down on the ink-marks, reads off the length. For comparison and measurement both limbs should be laid in the same position. It must be remembered that normal limbs are subject to slight variations in length—the left leg being not infrequently longer than its fellow; and again, old inflammatory affections may gave modified growth by causing increase or decrease in length. The surgeon should also gently pass his finger along the line of the fractured bone, noting any irregularities, as well as the locality and extent of the area where the patient has pain or tenderness. If the fractured surfaces be brought into apposition the feeling of **crepitus** is often elicited. Where of parallel bones one only is broken, there is usually little displacement, and crepitus is not always to be obtained with ease. The plan of placing the fingers at each end of the bone, and making pressure while they approach each other, will aid largely in showing the seat of pain and obtaining characteristic crepitus. Thus in fracture, pressure *at a distance* will localise pain at the injured spot; in a bruise this does not occur. In doubtful cases an X-ray photograph should be taken if possible. Failing that muscles in spasm may be soothed by massage, so as to permit a satisfactory examination to be made; should there still be uncertainty a general anæsthetic is indicated. During the relaxation thus produced the sound and the injured limbs should be carefully compared after the best possible restitution.

Methcds of Treatment.—Having diagnosed the fracture the surgeon has next to consider the best method of treatment, and at the present time (1913) there are different methods, the relative value and scope of which he has to be acquainted with. These may be indicated as follows:—

(1) The old *immobilisation method*, which consisted in setting the bones and fixing firmly with splints, not only the seat of fracture, but also the joint above and the joint or joints below the broken bone. This immobilisation was kept up until the bone was united, which took place in from three to six or eight weeks. After that in many cases the limb was enclosed in plaster of Paris for several weeks to allow the union to solidify. On removal of the plaster the patient was told to use the limb. However, great difficulty was generally found in doing so, and a long and tedious convalescence had to be faced to restore more or less completely the functions of the joints and muscles.

The guiding theory in this method was that the slightest movement

at the seat of fracture during the healing process would prevent bony union. The theory, however, is now known to be erroneous. Broken ribs heal readily in spite of the movements of respiration, and the success of the massage and early movement treatment has removed any lingering doubt on the subject.

Rigid fixation, by impeding circulation, delays union of the bones and encourages atrophy of the muscles, while it permits of adhesions to form in and around joints, also between muscles and around nerves. Once these adhesions have formed, it is generally difficult and often quite impossible to get rid of them.

The argument for immediate operation in simple fracture is based on the bad effects—frequently irremediable—which the old immobilisation method produced on the soft parts.

(2) The *massage and early movement method* introduced by Professor Lucas Championnière. In this method splints are used only to a limited extent, and their object is to prevent displacement—*i.e.*, to obviate mal-union, not non-union. They are not, however, discarded altogether, as some suppose. Massage is employed as soon as possible after the fracture, and is continued daily at first and afterwards at longer intervals. The object at first is to relieve muscular spasm and disperse effusion, afterwards to promote absorption of effused blood and lymph and maintain the nutrition of muscles. Combined with massage, movements of the adjacent joints, both active and passive, are cautiously employed to prevent formation of adhesions in tendon-sheaths and joints, and to help in maintaining the nutrition of the muscles.

The theoretical basis of this treatment is that rapid healing of the broken bone is promoted by the free circulation which is encouraged, while adhesions are prevented and the nutrition of the muscles maintained. Prevention is better than cure. Exact apposition of the broken ends of the bone is considered in most cases to be of less importance for future usefulness of the limb than free use of the joints and muscles. This has been proved to be true by experience in many forms of fracture. The bones heal much more rapidly than was believed to be possible under the older treatment and the muscles and joints are ready to resume their function when the bones are firm. The objections raised against this method are that it requires more time and attention than the immobilisation method, and that it does not give good results in every case. What these cases are we shall consider later, but in the suitable cases the results amply justify the trouble taken. The principles involved can be grasped, and the manipulations required can be learned, by any medical man, and he can have the treatment carried out in most cases by some sensible friend or relation of the patient, under his direction. In mining or other industrial centres it ought to be quite possible to have persons suitably trained to carry out the treatment under the local doctor's instructions.

(3) *The Immediate Operation Method.*—This is recommended by its advocates in most fractures of long bones in children and adults,

especially of the lower limb, and in probably the majority of fractures involving joints. Under rigid antiseptic precautions the ends of the bone are exposed, blood clots removed, and the broken fragments adjusted and held in exact position by steel plates fixed into the bone with screw nails.

The theory underlying this treatment is that, in the lower limb especially, restoration of function demands mechanical restitution of the shape of the bone, that without this restitution union is delayed, and that pain is necessarily caused when the limb is used by the altered strains in the bone resulting from the change in its shape.

It may be granted that exact reposition of the broken ends will hasten reunion, but no account is taken of the additional laceration of the soft parts involved by the operation nor of the delay in obtaining functional restoration owing to disuse of the muscles and joints during the healing of the wound. Again, the marvellous adjusting power shown in the process of repair in response to functional demands is under-estimated by the advocates of immediate operation. This is especially true in the case of fractures in children.

The operations on recent fractures require much surgical skill and a thoroughly reliable technique, otherwise bad functional results, amputations, or even deaths are liable to result. This makes it desirable to find a method which is more widely applicable with safety and yet gives satisfactory functional results. Such we believe to be furnished by Lucas Championnière's massage and movement treatment.

The scope of these methods may be indicated as follows :—

(1) The *rigid immobilisation method* may now in every case be modified since the massage and movement method has taught us that some movement is no obstacle, but rather a help, towards union. We seldom need to secure the joint above and the joint below the seat of fracture unless for the patient's comfort, and the limb may be massaged and the joints moved as often as convenient.

This modified immobilisation method will give good functional results in children in most fractures of the shafts and in adults in the same kinds of fracture (shaft of femur excepted) where there is no great displacement of the fragments nor severe laceration of soft parts. In fractures of the femur in adults, however, prolonged fixation is apt to lead to trouble in the knee, as will be afterwards explained.

(2) *Massage and early movement* is preferable to the modified immobilisation method in the above-mentioned classes of cases. It is the method of choice for fractures near or involving joints, such as fractures of the olecranon, and many fractures involving the elbow in children, so long as they do not require immediate operation (see paragraph 3), and in fractures of shafts with much laceration of soft parts and irregularity at the seat of fracture, so long as there is not much angular or axial deformity nor necessity for complete restoration of length of limb as it is in the lower limb of men in the public services It is also to be preferred to the modified immobilisa-

tion method in fractures otherwise suitable for operation where that is contra-indicated by the patient's age, constitution, local sepsis, or to other sufficient cause.

(3) *Immediate operation* where reliable technique is available is the method of choice in transverse fracture of the patella in healthy adults, in joint fractures where the fragments mechanically hinder movement, in cases where the important muscular attachments are torn off and cannot be approximated, where a nerve is involved or soft parts prevent the fragments from coming into contact, or where angular and axial deformity cannot be restored by manipulation or posture, especially in the lower limb, or again where the patient's occupation necessitates walking without a limp, as it does in the army or police force. For such cases *adequate* operative treatment should be obtained.

Contra-indications for operation in cases otherwise suitable—

(*a*) Where the bones are brittle from old age or other cause.

(*b*) Where the patient's constitution is impaired by disease or alcoholic excess.

(*c*) Where there are aseptic abrasions of the skin near the seat of a simple fracture, hence also in many compound fractures.

Treatment of Distortion caused by Muscular Action.—The injurious action of the muscles is due at first chiefly to spasm, which is a reflex effect of the local injury varying with the excitability of the patient's nervous system, afterwards to tonic contraction, and possibly also to mechanical shortening of the muscles from infiltration with blood and serum.

Effusion is dispersed and spasm soothed by massage, while spasm and tonic contraction are counteracted—

(1) By relaxation of certain muscles by posture in some cases (mostly near joints).

(2) By fixation after rectification effected during general anæsthesia.

(3) By continuous extension produced by weights or elastic cord.

Where tonic contraction is resisted either by fixation or continuous traction a point of resistance or "counter-extension" is necessary. In the lower limb where the muscles are powerful this is very important. When weights are used, the patient's bed is tilted so that the body weight acts as the counter-extending force. The points of pressure are thus widely distributed, but where the body weight is not used the counter-extension must be applied to one or two definite points on the patient's body. Thus with a long splint or a Thomas knee splint counter-extension is borne at the pelvis chiefly against the tuber ischii. The skin is then apt to be chafed, and constant care and watchfulness is needed on the nurse's part. In many cases in spite of all care any effective pressure is unbearable.

Some surgeons, however, prefer to oppose both spasm and tonic contraction if possible by fixation rather than by continuous traction. They believe that the very adaptability of the continuous method is its weak point, because when any movement, however slight, is possible at the seat of injury a reflex spasm is liable to be set up,

whereas rigid immobility obviates this. This objection, however, seems to be valid only when the weight employed is insufficient. Formerly, a weight of 6 or 8 lbs. was considered sufficient for the thigh muscles of an adult; more recently the weight has been raised to 30 lbs. or more. In especially difficult cases, especially those of long standing, Steinmann's pins, which act directly on the bone, are of the greatest value.

In the upper limb, where the muscles are not so strong and shortening of less importance, continuous extension is seldom required.

Setting of the Fracture.—The setting of the fracture and its retention in the proper position depend on a knowledge of the chief displacing cause. This varies greatly. The *force* itself may have been the means of carrying the broken ends apart, and all that is needful, now that the violence has expended itself, is simple reposition. Again, *muscular action* may have wrought the evil, or may keep fractured surfaces asunder; in which case, relaxation by position of the muscles concerned, or gradual exhaustion of them by means of continuous extension will succeed. The weight of the limb, causing an outward rotation or separation of surfaces, is easily counteracted by giving support. The nature of the *line of fracture,* be it transverse or oblique, is also a matter of great moment, and must be taken into careful consideration in adopting a mode of treatment. Before setting the fracture, make sure that your splints are of the proper size. This is easily done by shaping them on the normal limb.

All being in readiness, the surgeon sees that the limb is firmly and steadily grasped *above* the seat of fracture by an assistant, while steady continuous extension is made *below*—the surgeon laying his fingers over the fracture, and manipulating there, if need be. The splints are then applied.

In regard to treatment when confinement in the horizontal position is essential, the patient should always have a good firm bed, into which he cannot sink. For this purpose, nothing is better than a well-stuffed, double-quilted, hair mattress. When such a bed cannot be obtained, and the ordinary mattress is soft and yielding, a wooden board may be placed beneath it.

The position of rest for every joint is one intermediate between its possible extremes of movement in different directions, hence some relaxation from such extremes should be secured if possible when a limb is fixed up for any length of time.

Prognosis.—The prognosis will depend largely on the nature and site of the break, and the habits, age, and circumstances of the patient. Fractures in the vicinity of joints, and in old and rheumatic people, are very apt to be followed by stiffness; while in young people an early ossification of the epiphyses may arrest growth.

Material for Splints.—Gooch's splint, consisting of strips of lath glued to a backing of wash-leather, canvas, or strong paper, is supplied in rolls, and can readily be cut as desired. It is very serviceable in treating fractures of the long bones. Wire netting, perforated

sheet zinc and tin, can also be fashioned without difficulty as required. Millboard and leather cut into shape and softened with water are extremely useful, and may be readily adapted; this is also the case with the more expensive poroplastic, which consists of felt, impregnated with resin. Strips of tin, shavings, cardboard, corrugated paper, hanks of lint, and bandages, may also be incorporated with plaster of Paris, and other stiffening agents, as will afterwards be described in discussing fixed forms of apparatus. Splints require careful padding, and this padding should be soft, elastic, and somewhat resilient, so that it does not cake. Raw wool, washed as it comes from the fleece, oakum, and lint are rather better than cotton-wadding. Careful adjustment, so that hollows are filled up, bony points guarded, and equal support and pressure exercised, should be attained. If possible, a dependent position of the fractured limb is to be avoided, since it favours œdema; where the limb must hang more or less, a well applied bandage will largely obviate the difficulty.

Union is demonstrated when, after the lapse of time necessary for repair, there is no movement at the seat of fracture. The surgeon fixes one extremity of the broken bone, and gives the other lateral, antero-posterior, and rotatory movements, and thus judges of bony continuity. In doubtful cases it is well to have these movements executed by an assistant, while the surgeon handles the fractured region.

Delayed Union.—This term is applied to a slow development of callus, and is due sometimes to deficiency in the general health of the patient, sometimes to want of active circulation at the seat of the fracture. It is less likely to be met with under the massage and movement treatment than when the circulation of the parts is interfered with by prolonged fixation in splints. The indication for treatment is to stimulate the circulation at the seat of fracture, and this may be done in several ways One of the best and simplest is to produce passive congestion by applying round the limb above the fracture an elastic bandage tight enough to retard the venous return and cause some swelling and bluish discoloration of the limb below. The bandage may be kept on for about twelve hours out of the twenty-four, preferably at night. This method was introduced by the late Owen Thomas in 1878 under the title of "damming," but was not much used until it was independently discovered and advocated some years later by Professor Helferich. Another method, which Owen Thomas practised with success, is described by him as "hammering." It may be performed at intervals of about a week under an anæsthetic by wrapping the seat of fracture in a towel and beating it with a hammer or mallet, or without an anæsthetic by daily percussion for a few minutes as firmly as the patient can bear. "Hammering" can be best applied to subcutaneous bones, but it may be also to those that are clothed with muscle, care being taken not to damage nerves or large blood-vessels. "Hammering" and "damming" may be used with advantage together.

Forcible rubbing of the ends of the bones against one another, with

or without an anæsthetic, may be used independently, or to supplement the "hammering" or percussion.

Professor Bier has obtained very good results in both delayed- and non-union by the injection of the patient's own blood at the seat of fracture. By means of a strong 30-c.c. syringe armed with a hollow needle, from 15 to 30 c.c. of blood are withdrawn from a vein in the patient's forearm. The needle is thereafter thrust into the seat of fracture, and the blood is injected between the bones and, as far as possible, under the periosteum. All necessary precautions are, of course, taken to render the procedure aseptic. When these measures fail, operative methods will have to be employed.

"*Greenstick Fracture*" is the term applied to the bending which bones in children are prone to undergo in place of fracture. Treatment is that of fracture. During the forcible replacement the bone may give way completely. The collar-bone and forearm are most commonly affected.

Dislocation *versus* Fracture.—It is convenient to consider dislocation along with fracture. The general characters of *dislocation* are fixation and distortion of the joint involved, due to a change in the relative position of the bones which form the articulation. *Fractures*, on the other hand, display abnormal mobility and distortion as regards the relation of certain parts of the bone to each other at the seat of injury. It is only when fractures occur in the vicinity of joints, more especially if of the nature of diastasis (epiphyseal detachment with no true crepitus), that there is difficulty in coming to a definite conclusion. By manipulation and support, we may restore the outline of a broken bone. Deformity again occurs when we remove the support. On the other hand, a dislocation is difficult to replace; but, when once reduced, tends to maintain its position. Naturally, there are numerous exceptions to such generalisations, as when, for example, dislocation occurs at some shallow ligamentous joint presided over by powerful muscles, in which case, although reduction be easy, retention is even more difficult than in fracture. In all doubtful cases recourse should be had to an examination with X-rays.

The sooner a dislocation is reduced the better. This can in many instances be effected by rapid manipulation if one takes the patient unawares. Failing this, the administration of an anæsthetic will remove all difficulty. The limb is then to be kept at rest, and after a suitable period of quiet, passive motion is carried out.

B. Special Fractures—Upper Extremity.

Fractures of the Clavicle.—The Middle Third is the most common situation. The break is caused occasionally by direct, but more frequently by indirect, violence through a fall on the shoulder or outstretched arm.

The attitude of the patient in a recent case is characteristic. The elbow of the affected arm is supported with the other hand, and the

patient inclines his head towards the broken bone. If in a suspected case the patient can easily abduct his arm, there will probably be no fracture. If the swelling masks the condition of the bone even to the touch, the surgeon should move the outer end either directly or through the medium of the shoulder, while with his other hand he steadies the inner part of the bone In so doing, he will elicit crepitus or abnormal mobility.

Treatment.—Should it be important to avoid irregularity at the seat of fracture, which, however, would not affect the functional usefulness of the arm, the patient must be kept in bed, lying upon a firm mattress with a pillow between the shoulders, the arm being supported against the side by a bandage or sling. In this position the trapezius is relaxed, and the weight of the arm brings the broken ends into apposition. None of the appliances, which have been devised to prevent the over-riding of the broken ends during ambulant treatment, have succeeded in their object. They have all given results good as regards function, but imperfect as regards apposition. The results are no better than those which have been obtained without apparatus. These remarks apply to forms of apparatus in which an axillary pad is used to keep out the arm, to the Sayre plaster method and its modifications, and to the various more or less complicated bandage methods.

In a recent case the pain will be soothed by hot fomentations and by massage. The weight of the arm should be supported by a sling tied over the opposite shoulder (p. 141), and the arm bound to the side.

Massage and movement should be employed daily for the first week, every second day for another week, and at longer intervals for the third week. The sittings should last for about twenty minutes at first; afterwards a little longer. Massage the muscles acting upon the broken bone—*i.e.*, trapezius, sternomastoid, pectoralis major, and deltoid; also the soft parts near the bone, and the bone itself. Passive movement of fingers, wrist, elbow and—gently—of shoulder at the beginning of the earlier sittings. On the second day and onwards allow active movement. At first this should be limited, as regards the shoulder, to a gentle swinging movement, and to gentle movements of the other joints. About the fifth day active movements of the shoulder may be permitted in all directions.

The sling which supports the arm should be worn under the shirt for the first week, after that over the clothes. It will probably not be required after three weeks.

The Outer End.—(*a*) *Beyond the Conoid and Trapezoid Ligaments.*—Caused by a blow upon the back of the shoulder, due to a fall or otherwise. Diagnosis is from the history, pain on movement, and crepitus.

Treatment.—There is no downward displacement, but the shoulder tends to rotate forwards; hence where appearance is of importance the shoulders must be braced back with a figure-of-eight bandage or with padded handkerchiefs (Figs. 86 and 87, p. 153), and the arm at

first carried in a sling. Massage and movement as for fracture of the middle third, except that there will be less massage and more movement.

Use of Padded Axillary Handkerchiefs.—In fractures beyond the coraco-clavicular ligament and in others which are attended

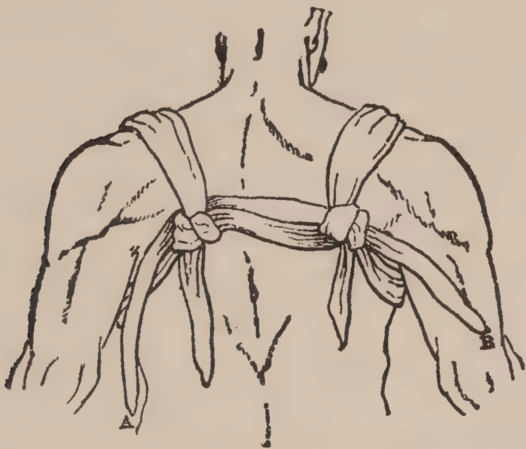


Fig. 86.—Fracture of the Clavicle.—Treatment by bracing back the shoulders with knotted handkerchiefs. The ends, A and B, to be tightened and tied in the middle line behind.

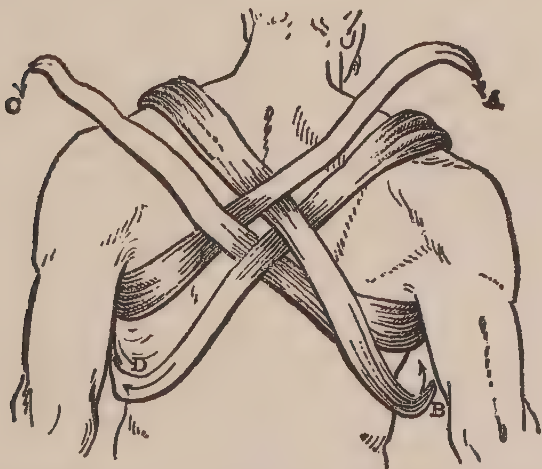


Fig. 87.—Method of bracing back the shoulders with Interlaced Handkerchiefs, A B and C D.

with marked forward displacement, or where the patient is rather intractable, the shoulder may be braced back by means of two padded axillary handkerchiefs (Fig. 86). The presence of knots behind may be obviated by interlacing the ends and tying in front (Fig. 87).

(*b*) *Between the Conoid and Trapezoid Ligaments.*—Caused by a downward blow upon the outer end of the clavicle. The clavicle is

thought thereby to be broken across the coracoid process. Diagnosis as in (*a*).

Treatment.—There is no tendency to displacement; treat as for fracture of the middle third.

The Inner Third.—Caused by force applied along the line of the bone. Diagnosis is based upon the history, pain on movement, swelling of the soft parts, irregularity of the outline, and crepitus.

Treatment as for fracture of the middle third.

Fractures of the Scapula.—These are caused by severe crushing of the thorax, and are generally accompanied by fractures of the ribs Dyspnœa and much pain are caused by spasm of the large muscles which are involved. Diagnose from the history of the injury, spasm of the muscles of the shoulder, irregularity of the subcutaneous parts of the bone, and crepitus on movement.

Treatment.—Massage the swelling and the muscles of the shoulder and upper part of the thorax In the interval, support the scapula by a bandage round the chest, and steady the arm with a sling. Fractured ribs are no contra-indication to massage. Adhesive plaster, if applied to the chest on account of the broken ribs, will support the scapula also, and massage can be carried out over the plaster. Massage should be employed daily at first, and at longer intervals afterwards. Passive movements of the shoulder while the scapula is steadied should be begun as soon as spasm has passed off Active movements of the fingers and elbow should be encouraged early, and of the shoulder as soon as the patient can perform them without pain.

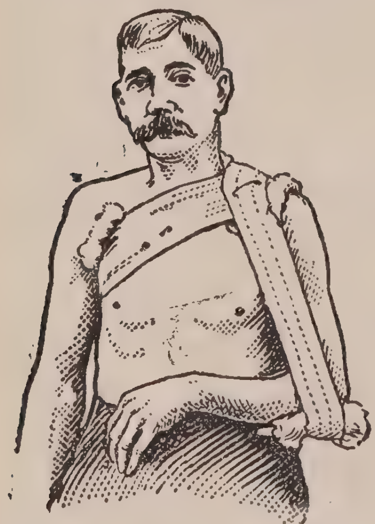


Fig. 88.—Method of supporting Elbow in Fracture of the Acromion Process

The Acromion Process.—Caused by direct violence a blow, or a fall upon the shoulder. Diagnosed by the history of the injury, drooping of the arm, and inability to use the deltoid; local tenderness and crepitus.

Treatment.—The elbow should be supported as follows:—Prepare pads of wool for the outer third of the clavicle and point of the elbow of the injured side and for the axilla of the opposite side. Now an assistant raises the elbow of the injured side and holds the pads in position, the surgeon makes a figure-of-eight with the elastic bandage. Beginning at the opposite axilla he crosses the top of the shoulder, runs down under the elbow, up to cross the shoulder pad again, and thence goes back to the axilla. A light strain on the elastic is sufficient (see Fig. 88). Massage to some extent can be employed without disturbing the bandage, but it can be easily removed and replaced

every few days for movement, and it should not be needed for longer than two or three weeks. A bandage or sling to steady the arm is advisable at first, and passive and active movements on the same general principles as in fracture of the bone.

The Coracoid Process.—This is very rare, and is due to direct violence. The diagnosis is difficult. It may be suspected owing to pain on movement which involves the coraco-brachialis and biceps muscles, and may sometimes be established by crepitus and pressure over the coracoid process. An X-ray photograph is advisable in this and all other injuries about the shoulder where the diagnosis is doubtful.

Treatment as for fracture of the acromion process.

The Neck of the Bone.—This is a very rare injury, and is important because the symptoms resemble those of downward dislocation of the humerus It is caused by direct injury. The symptoms are like those of a downward dislocation of the humerus, with the difference that the flattening of the shoulder and lengthening of the arm can be overcome by gently drawing away the arm from the side and then lifting the whole arm upwards. Crepitus will be felt as the parts return into position.

Treatment as for fracture of the acromion process.

Fractures of the Humerus—Upper End.—*General Remarks.*—After a severe injury to the shoulder, the exact diagnosis may be a matter of great difficulty. Besides fracture or dislocation of the upper end of the humerus, or both, there may be present fracture or dislocation of the outer end of the clavicle, or fracture of the acromion process.

The steps necessary for forming a diagnosis should be taken (see p. 144).

There are two main reasons why, after fracture of the upper end of the humerus, the patient may never regain a proper functional use of the shoulder. (1) The upper fragment is in some cases greatly tilted upwards and outwards (abduction) by the action of the supra-spinatus muscle; this sometimes occurs in separation of the upper epiphysis, and in high transverse fractures of the surgical neck. It will be evident that if union takes place with the upper fragment strongly abducted and the lower fragment lying against the side of the body, abduction of the arm will afterwards be impossible at the shoulder joint. There are two ways of preventing this mal-union :—An operation may be performed, and the ends of the bone brought together and held there by plates, wires, or pins; or, if under an anæsthetic the lower fragment can be brought up to the upper one, the broken limb may be treated in the abducted position; (2) the shoulder joint and the surrounding muscles may be matted by adhesions. This is apt to occur in all fractures at the upper end of the humerus as the result of prolonged immobilisation, and is the commoner cause of the functional disability; but fortunately it is one which can be obviated by massage and movement. Where the muscles can be kept functionally active and the joint free from adhesions by this

treatment, good functional results will be obtained, even although there may be considerable over-riding of the broken ends or a medium amount of angular deformity. In the latter case, an increased mobility of the scapula will compensate for the restricted movements at the shoulder.

Fractures at the Upper End.—The injury may be (*a*) *of the Anatomical Neck;* (*b*) *of the Greater Tuberosity;* (*c*) *of the Surgical Neck;* (*d*) *Separation of the Epiphysis.*

(*a*) *Fracture of the Anatomical Neck.*—This is usually caused by direct violence, as in a fall upon the shoulder, and is often accompanied by comminution of the tuberosities. Should the upper fragment be separated from the rest of the bone, non-union is likely to occur and operation will be, therefore, indicated (see p. 148); but if there be impaction, union will probably take place.

Treatment.—Massage should be begun at once (see general instructions), and should be continued daily for about a month. Passive movement of the shoulder should also be employed from the first, very cautiously of course to begin with, and gradually increased Active movements of the shoulder may begin about the fourth day; at the first only slight movements of abduction, then movements forwards and backwards, and last of all movements of rotation.

The only apparatus required is a simple sling to support the forearm, the hand being left free so that active movements of the wrist and fingers may be made from the first. For the first day or two, if there is much pain, the patient will be easier in bed with the arm bound to the side. After the pain and spasm have subsided, he can go about with the sling beneath the clothes until after the fourth day; the sling may then be worn outside the clothes. All movements are to be controlled by pain and fatigue. Union is generally complete in a month, but treatment should be kept up until the movements are quite free.

Where there are simultaneous fracture of the neck and dislocation of the head, a serious operation will probably be required.

(*b*) *Fracture of the Greater Tuberosity.*—This may sometimes be recognised by the presence of crepitus and of increased breadth of the shoulder, while by a finger in the axilla the head of the bone can be felt to move with the lower end of the shaft. In doubtful cases an X-ray photograph should be taken.

The *Treatment* is much the same as for fracture of the anatomical neck, with this difference, that the massage must chiefly be applied to the supra- and infra-spinatus and teres minor muscles at first, that movements of rotation must be carefully watched, and that at first the joint must be kept from the formation of adhesions chiefly by swinging movements, others being added by degrees. A sling is needed as for the fracture of the anatomical neck. In some cases where massage fails to reduce the muscular spasm an operation may be necessary.

(*c*) *Fracture of the Surgical Neck.*—This is caused most frequently by a fall upon the shoulder; sometimes by a fall upon the hand or

elbow. The diagnosis is based upon the tilting outwards of the lower end of the humerus, the head of the bone being in position, and increased mobility with crepitus, at the upper end of the bone. A general anæsthetic may be necessary to establish the diagnosis and allow the fracture to be set, should massage fail to ensure the necessary relaxation of spasm.

Treatment.—In the majority of cases the treatment which answers best is that recommended above for fracture of the anatomical neck. The upper fragment, if markedly abducted, which, however, is the exception, cannot be controlled by splints; hence, in such cases the lower fragment must be brought to it by being placed in the position of abduction. Middeldorpf's abduction splint in the form of a triangle can be easily made of wood, perforated zinc, or tin (Fig. 89). The

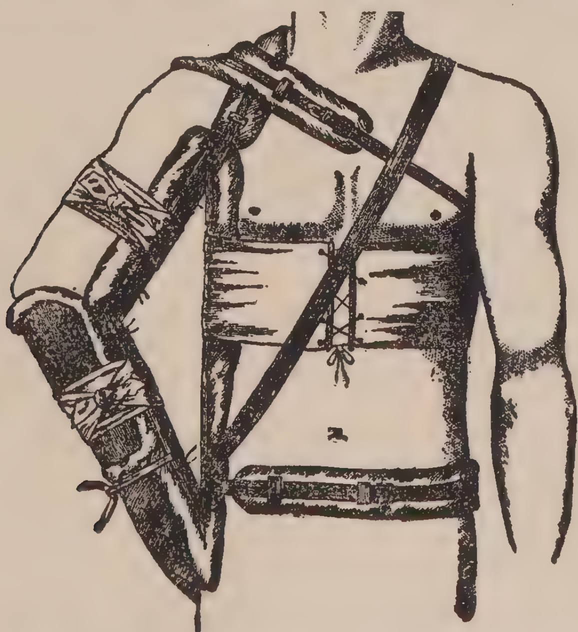


Fig. 89.—Middeldorpf's Triangle (*after Esmarch*).

base of the triangle rests against the patient's trunk, while the other sides of the triangle support the upper and forearms respectively. Should the abducted position fail to keep the ends in fair apposition, the question of operation must be considered.

The abduction splint may have to be employed for two or three weeks; but during that time the shoulder should be massaged every few days, and movements of the elbow and fingers encouraged. On the removal of the splint, a cushion should be employed as in the next case. This in turn should be dispensed with as soon as possible, probably in a week or two.

In cases where the upper end is not much tilted outwards, but in which the lower fragment is drawn inwards by the muscles inserted

into the bicipital groove, the broken ends can be kept in position by laying the arm upon a wedge-shaped cushion which has its apex in the axilla. This cushion may be conveniently formed of a piece of cardboard bent upon itself, filled up with cotton-wool, and padded on the outside. The arm is then laid upon this cushion and bandaged to the side. After four or five days the bandages are loosened, the parts massaged and gently moved, and the arm again fixed up as before. This massage and movement are repeated in a few days, and generally at the end of about ten or twelve days the cushion can be dispensed with and only a sling employed.

(*d*) *Separation of the Upper Epiphysis.*—This injury occurs in persons under twenty years of age, usually from direct, but sometimes from indirect, violence; in fact it is often the result of an injury which would have caused a dislocation of the shoulder in an older person.

The symptoms resemble those of subcoracoid dislocation as regards the axis of the humerus and the presence of a prominence under the coracoid process. If the swelling is not too great, however, the head of the bone may be recognised in the glenoid cavity.

Treatment.—Under a general anæsthetic an effort should be made to restore the separated parts. The head of the bone is steadied with the fingers of one hand, while the arm is drawn away from the body and gradually abducted to its extreme limit. When the displacement is reduced, the limb is fixed in the abducted position by a Middeldorpf's splint or by means of a plaster-of-Paris case. In the latter case massage has to be postponed, but in a young person this is of less importance. After two or three weeks the plaster-of-Paris case is removed, and the limb massaged and cautiously exercised. If the separated portions of bone cannot be brought into line an operation will be indicated.

Fractures of the Shaft.—These are caused usually by direct violence, but sometimes by a fall upon the hand or wrist, or by a twist.

Diagnosis is generally easy on account of the deformity and increased mobility; non-union is common, but this does not seem to be due, as was formerly supposed, to movement of the fracture during the course of treatment, but to interposition of soft parts, or to the imperfect blood-supply of the lower fragment owing to tearing of the nutrient artery.

Treatment.—It will be necessary to make sure that the musculospiral nerve has not been torn at the time of fracture, or nipped between the fragments when the bones were being set. If the nerve has been torn, the ends must be sutured at once by operation. After massage, the ends of the bone can generally be brought into apposition. Although some cases can be treated with a sling only, without splints, combined with massage and movement, it will generally be advisable to encircle the limb with well-padded supporting splints, one at the outer and back part of the arm with an excavation over the outer condyle, and another shorter splint for the front and inner side.

These may be made of Gooch's splint, poroplastic felt, or pasteboard. They must be well padded, and fixed tight enough to prevent angular deformity, but not to interfere with the circulation of the limb (Figs. 90 and 91). The arm should be kept in a sling. The fingers and wrist should be moved voluntarily from time to time by the patient, and passive movement of the elbow and shoulder should be made at the massage sittings every few days. At first the support of the splints should be maintained during the passive movements. The splints may be required for about three weeks. Union generally takes place in about four weeks.

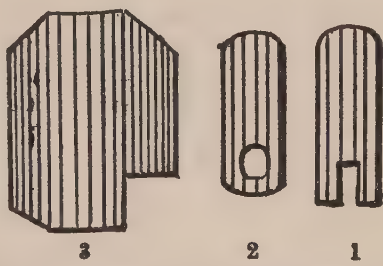


Fig. 90.—Gooch-Splints shaped for Fracture of the Humerus—Nos. 1 and 2 are cut to avoid pressure on the internal condyle, 3 is used to command the rest of the arm, as in Fig. 91.

If signs of involvement of the musculospiral nerve should appear during the formation of the callus, time should be given for the callus to consolidate and contract. If the nerve seems to be permanently

Fig. 91.—Treatment of Fracture of the Humerus. (The bandage for the hand and forearm is only necessary for a few days, if at all.)

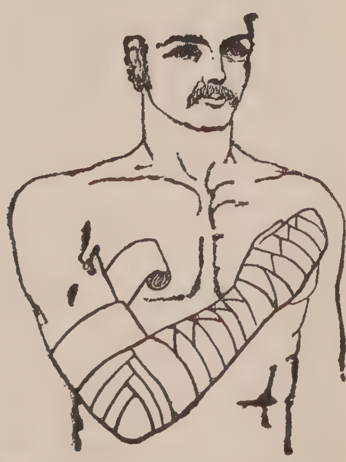


Fig. 92.—Fracture implicating the Elbow-joint treated in the flexed position.

involved, an operation to free it will be necessary. Massage should not be applied to the seat of fracture in such a case, as the callus will be thereby increased.

Delayed Union.—Should union be delayed, the activity of the healing process may be hastened by the measures already indicated for that condition (*vide supra*).

Fractures near and into the Elbow Joint.—(*a*) Transverse fracture at the olecranon and coronoid fossæ; (*b*) T-shaped fracture; (*c*) separation of the epiphysis; (*d*) fracture of either condyle; (*e*) fracture of either epicondyle.

These fractures are often very complicated and difficult to diagnose. The swelling is often great, and one or more of the fragments may be very small. After the history has been obtained and the aspect of the limb and possible voluntary movements have been observed, the following method of examination will be found useful, even when the swelling is great. Begin by massaging above the elbow, and try to reduce the swelling round the joint as much as possible; then follow with the fingers the subcutaneous ridge of the ulna from the forearm to the olecranon process, and see if the olecranon is fixed or transversely movable. Then compare the relations of the condyles with the olecranon on the two sides of the body. Grasp the lower end of the humerus by the condyles, and see if it is continuous with the shaft or not by making a movement in the transverse direction. Take each condyle separately between the finger and thumb, and try to move it antero-posteriorly. The bony points, although obscured by the swelling, can generally be made out by steady pressure over the place where they should be. In children, a transverse fracture through the olecranon fossa often occurs, even although the epiphysis has not united. A general anæsthetic and X-ray photograph should be employed where there is any doubt as to the diagnosis.

Treatment.—If displacement be slight or absent, keep the arm in a sling, and treat by massage and movements only. If displacement be well marked, reduce (under an anæsthetic if necessary), and bandage the arm into a rectangular posterior gutter-splint of metal, poroplastic felt, or plaster. If displacement be very great, reduce as before, but fix the elbow in acute flexion. Many surgeons prefer to adopt the acute flexion position in all cases. A small pad is placed in the bend of the elbow, and a figure-of-eight bandage put round the joint. Operation will be necessary if the symptoms point to the involvement of the ulnar nerve, or if the fragments cannot be properly moulded into position and retained there.

Massage and movement are of especial value in all fractures into the elbow joint. Unless there is great tendency to displacement of the fragments, this treatment should be carried out daily at first. In addition to the general indications already given, the following points should be attended to. While the effusion should be dispersed as soon as possible, care must be taken not to stimulate the formation of callus by massaging the seat of fracture itself, especially in young children. The broken bone must be steadied during massage, and especially during active and passive movements. The masseur must make sure that any movement that takes place does so at the joint and not at the seat of fracture. The amount of movement must be

regulated by the pain. Where pain restricts movement, there will be no gain in forcing the movement, which only calls forth contraction of the antagonistic muscles.

Where displacement tends to recur, the splints may be left undisturbed for two or three days. After about a week, the tendency to displacement will be very slight. On the other hand, if displaced fragments have not been replaced for ten to fourteen days, it will be difficult to rectify the position, even under an anæsthetic. Improvement in range of movements sometimes goes on for many months after the fracture has united, the patient's own voluntary efforts being of much assistance.

The Olecranon.—This injury is generally caused by direct violence, sometimes by the action of the triceps. Diagnosis is generally easy by manipulation (see method of examining for fractures of the lower end of the humerus). The patient's power of extension should be tested when the forearm is allowed to hang vertically from the abducted upper arm—*i.e.*, in extension against gravity.

Treatment.—Formerly an apparatus was applied to keep the elbow extended and to draw down the upper fragment of the olecranon. This method, however, Lucas-Championnière finds quite unnecessary if the massage and movement treatment be carried out. The only appliance required is a sling, in which the arm rests at first at an angle of 135°—*i.e.*, midway between full extension and a right-angled position—while round the elbow a bandage may be lightly applied, partly to support the parts and partly to meet the patient's desire to have some form of apparatus.

For the first day or two the patient may be more comfortable in bed with the arm lying on a pillow in a semi-extended position. In a day or two he will be able to get up and go about with the arm in a sling. The massage should be carried out with the limb in the most comfortable position, which is generally that of slight flexion, the limb lying on a cushion. After the use of the stroking movements already described for soothing the muscles, gentle passive movements may be made, and so long as they do not excite muscular spasm they will not lead to separation of the detached fragments. The massage sittings are repeated daily, but for several days passive movement only is allowed at the elbow; gentle active as well as passive movements of the wrist and fingers are encouraged.

As the tenderness subsides, the massage is applied more deeply round the elbow joint, and the range of movement is extended. It should be remembered that active flexion and passive extension movements are least likely to do harm. Usually complete flexion is possible in about three weeks, but full extension is often delayed; sometimes it is never quite regained. For many weeks after the movements of the joint are free, the patient must abstain from any violent muscular exercise, especially such as will bring the triceps into strong action, lest the uniting callus should be stretched or torn.

Professor Lucas-Championnière finds that operation is not required in fracture of the olecranon treated by his method, and this has been amply confirmed in the Royal Infirmary of Edinburgh.

Fracture of Both Bones of the Forearm is caused most frequently by direct injury. Diagnosis is easy from the deformity and increased mobility.

Treatment.—The fracture, if below the middle of the arm, must be set after relaxation of the muscles by massage or by a general anæsthetic. During reduction the supine position may be adopted with advantage. Splints must be employed to prevent recurrence of deformity. They must be broader than the forearm, and rigid, so that the broken ends of the radius and ulna are not pressed together (Fig. 93). The most convenient material is Gooch's splinting, applied

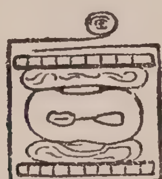


Fig. 93.—Diagram of Section of Forearm, showing preservation of interosseous space by means of suitable pads and board splints.

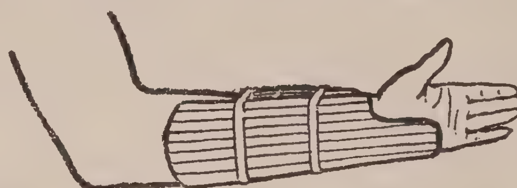


Fig. 94.—Gooch-splint cut away to avoid pressure on the ball of the thumb.

with the wood towards the limb. The posterior splint should extend from the olecranon, and the anterior splint from the bend of the elbow, to the wrist. This will allow free movement of the fingers and slight movement of the wrist.

After the first soothing massage the splints may be left undisturbed for four or five days. They will then be taken down and the limb massaged while the bones are steadied by an assistant. Slight movements of the elbow are possible with the splints in position, and hence do not need to be carried out at the massage sitting. Pronation and supination must be passive only at first, but even these must be delayed until all muscular spasm has subsided and the parts are beginning to solidify. While the patient is going about, the limb is laid in a sling in the supine position as much as possible.

Fracture of the Ulna alone, and fracture of the *Radius alone* between the insertion of the pronator teres and the lower end of the bone, are to be treated as for fracture of both bones.

Fracture of the Radius above the insertion of the Pronator Radii Teres—*i.e.*, in the upper half of the bone, with or without simultaneous fracture of the ulna—is caused by direct violence. The importance of this fracture is that the upper fragment of the radius carries both supinator muscles—biceps and supinator brevis—while the lower fragment has both pronators. The upper fragment rotates on its own axis, and cannot be prevented from remaining in supination. The lower fragment can, however, be controlled. Hence it is necessary

to maintain the forearm in the position of full supination and flexion for two or three weeks, the massage and movement being carried out in other ways as if both bones were broken below the middle. The position of full supination cannot be voluntarily maintained by the patient without mechanical aid. Besides lateral splints, therefore, as for fracture of both bones, an additional splint is necessary to keep up supination. An angular elbow splint bandaged to the forearm splints will serve the purpose, or a straight piece of Gooch's splint about 3 inches broad, laid across the angle formed by the upper arm and the forearm splints, and fixed there with a firm bandage.

Fracture at the Lower End of the Radius (Colles's Fracture)—the commonest fracture in the body. A prominent feature, most useful in diagnosis, is afforded by the examination and comparison of the styloid processes of the bones of the forearm on each side. When this fracture has taken place, the styloids are on the same level, whereas, in the normal limb, that of the radius is more prolonged downwards. In the absence of this symptom and of all typical displacement, it is advisable to treat as Colles's fracture the cases where marked tenderness on pressure exists, distinctly localised to the radius just above the wrist, and associated with a history of a fall on the palm.

Fig. 95.—Setting a Colles's Fracture.

Two unfortunate possible sequences of this accident have to be obviated as much as possible by this treatment. One is deformity, which results from not reducing the fracture. The other, and more important, is stiffness of the wrist and fingers which results from immobilisation. There is no necessary connection between these two. Many unrecognised cases of Colles's fracture have left a perfectly good functional result along with great deformity, because the patient has kept on using the wrist, although no attempt has been made to reduce the deformity. On the other hand, functional results have often been very poor in cases where deformity is slight if the wrist and fingers have been rigidly immobilised for several weeks.

Treatment.—As soon as the fracture has been recognised, the displacement should be reduced. A few minutes' massage of the arm, above the fracture, is of service as a preliminary. An anæsthetic is generally necessary, but as the obstacle to reduction is osseous rather than muscular, gas and ether, or ethyl chloride, may be employed. The best way to reduce is to grasp the hand firmly and

begin by over-extending the wrist, which should be steadied by an assistant; then try to separate the fragments, while keeping up this position, and afterwards, while maintaining the strain, gradually and strongly flex the wrist and simultaneously force forward the lower fragments with the thumb of the disengaged hand (Fig. 95). It may be necessary to repeat this manœuvre once or twice before the osseous deformity is rectified or materially improved. Some deformity will remain, due to effusion in the soft parts, but will gradually disappear.

After reduction, the limb should again be massaged, and then the question of apparatus has to be considered. Deformity does not easily recur after reduction; hence some surgeons recommend that no splints be employed at all. There are, however, two reasons why a simple splint may often be advisable. If there is muscular spasm, a certain amount of deformity may be reproduced by the action of the muscles; moreover the tenderness of the wrist often makes it very painful for the patient to steady his wrist if it is allowed free play. In severe cases it is therefore better to lay the hand and forearm on a well-padded anterior splint reaching to the palm. To this the hand and forearm should be lightly bandaged, either with or without the additional support of a dorsal splint. Massage of the forearm and wrist should be performed, daily at first, on the general principles already laid down. After the first week the sittings may be less frequent.

Passive movements should at first be confined to the fingers. As the pain becomes less, the movements may extend to the wrist. Pain should be taken as the guide to the extent of the movements. Active movements of the fingers generally begin about the third day, and should be followed by slight active movements of the wrist as soon as the pain permits. Pronation and supination come last of all.

In cases where the displacement is slight and the pain not great, after reduction the wrist should be supported with a strip of plaster or a bandage, and the forearm laid in a sling with the hand hanging over the edge.

Injuries of the Carpal Bones.—The two most common injuries of the carpal bones are fractures of the scaphoid, and anterior dislocation of the semilunar bone, either separately or combined.

The cause is usually a severe twist or strain, such as might have produced a sprain.

Simple Fracture of the Scaphoid Bone.—Diagnosed even without the X-rays, from (*a*) "History of a fall on the extended hand; (*b*) Localised swelling in the radial half of the wrist joint; (*c*) Acute tenderness in the anatomical snuff-box when the hand is adducted; (*d*) Limitation of extension by muscular spasm, the overcoming of which by force causes unbearable pain" (*Codman* and *Chase*).

Treatment.—Rest of hand on an anterior splint for three or four weeks, with massage and gentle movement. If there is no union in that time, none probably will take place at all, and the wrist may remain permanently impaired in function. In that case operation is

indicated to remove the proximal portion of the broken bone. (See Codman and Chase, *Annals of Surgery*, vol. xli., for details of the operation, and for the diagnosis and treatment of dislocation of the semilunar bone).

Fracture of the First Metacarpal Bone.—The commonest fracture of a metacarpal bone is that of the base of the metacarpal bone of the thumb—"Bennett's fracture." It is caused by a blow in the long axis of the thumb (on the point), whereby the anterior portion of the surface which articulates with the trapezium is split off. A partial dislocation backwards results.

Treatment.—Extension; and replace the metacarpal bone, and prevent it from passing backwards again by the pressure of a firm pad held in position with a splintwhich reaches from the radius to the end of the thumb. Several forms of splint have been recommended. The most useful is a piece of Gooch's splinting, a little wider than the thumb and of the requisite length.

Massage for a few days should be carried out, also passive and active movements while the proximal end of the bone is steadied by the grasp of a finger.

Fracture of One of the Four Inner Metacarpal Bones.—An important help in diagnosis is the presence of shortening. When both hands are closed the level of the heads of the metacarpal bones can be easily compared on the two sides.

Treatment.—Bandage the forearm and hand to an anterior splint, with a good pad in the palm, or bandage the closed fist with a pad in the palm, and support the forearm in a sling. Massage the hand and forearm, at first daily. After the first week, at intervals of a few days. Passive movements of the fingers should be employed from the first. In a few days encourage slight active movements. Union takes place in about three weeks.

CHAPTER XV.

ON FRACTURES (*Continued*).

Contents.—C. Special Fractures of the Lower Extremity—General Treatment—Prevention of Bed-Sores—Application of Extension—Fracture of Neck of Femur; Diagnosis and Treatment; Intra- and Extra-capsular Varieties—of Shaft—in Children—near Knee—of the Patella—of both Bones of the Leg—Various Forms of S lint—Pott's Fracture; Treatment—General Remarks.

C. Special Fractures—Lower Extremity.

General Treatment.—A patient suffering from fracture of the lower limb requires treatment in bed. Prolonged recumbency can only be carried out on a suitable mattress such as has been already described (p. 149); it should be firm, even, and unyielding.

Prevention of Bed-Sores.—The formation of bed-sores must be carefully prevented. They occur wherever pressure is kept up over bony prominences, such as the sacrum, heel, region of the buttocks, and popliteal space. Moisture is their chief causation—be it due to urine, sweat, discharge, or lotions. In old and weakly patients, extreme watchfulness can alone combat bed-sores. The patient must be kept absolutely dry. The skin exposed to pressure may be strengthened by daily sponging with some hardening antiseptic lotion, such as spirits of wine and corrosive sublimate 1-2000, after which it must be carefully dried. In women it is advisable in many cases to draw off the water with a carefully purified catheter three times a day, and in both sexes the perinæum may be dusted with finely powdered boric acid. Bed sores may also be treated with advantage with picric acid (see under "Burns," p. 44). Some difficulty is usually experienced at first in the use of the bed-pan. Where the patient is strong enough, he may assist by flexing the sound limb, and raising his pelvis with the aid of his arms and leg, while the slipper is introduced from before. Mattresses are also to be had with a movable pelvic segment, which, on withdrawal, permits of the introduction of the bed-pan.

Treatment—General Rules.—Features common to the majority of fractures of the lower extremity are found in the tendency to distortion and shortening, owing to the greater strength of the muscles and frequent obliquity of the fracture, in the outward rotation of the lower fragment by action of gravity, and in the pointing of the toes due partly to gravity and partly to the tonic contraction of the calf muscles. Extension is required in many cases (see pp. 170, 230). The more or less extended portion of the limb is convenient in most cases. It enables us to tell at a glance whether or not the evertion has been remedied. The internal edge of the patella, the internal malleolus, and the ball of the great toe, should always be seen to lie in the same vertical plane when the limb is extended. The application of extension is treated of in detail at p. 230. In the case of fractures, the plasters should stop short just below the seat of injury. We now proceed to apply the necessary splints, buckle the foot-piece to the extension-straps, secure the pulley to the foot of the bed, and put on the weights.

Next raise the foot of the bed on props, and the patient's body acts as the counter-extending force. The limb should be carefully measured every day; and whenever the limbs are of equal length, weight must be decreased. Take off weight also if there be pain in the joints below the fracture. Increase it, if there be starting pains at the site of injury.

Diagnosis of Fractures of the Neck of the Femur.—A good deal of the difficulty in diagnosing the intra- from the extra-capsular fractures may be traced to an imperfect understanding of what it is that really makes the difference between the two forms of fracture. The mechanism which produces it is different in each case. The *intra-capsular* fracture is caused by a twist or strain which acts transversely.

or obliquely to the long axis of the neck. The bone is not likely to give way from this form of injury unless it has been previously weakened by disease or senile atrophy. The *extra-capsular* fracture results from violence applied to the great trochanter—almost without exception from a fall upon it—and which therefore acts more or less directly along the axis of the neck. Aged and fragile persons, just as much as those who are younger, will suffer from this form of fracture, and not from the intra-capsular form, if they happen to fall upon the great trochanter. The *intra-capsular* fracture is a mere transverse break of the neck of the bone; it is very seldom impacted, but when this does occur the lower fragment—neck—is driven into the upper—head. The *extra-capsular* fracture is really a break between the neck and the great trochanter. It is always impacted—at first at least—and as the result of this impaction, in severe cases the trochanter is split up into several fragments.

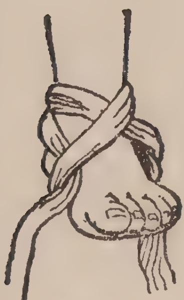


Fig. 96.

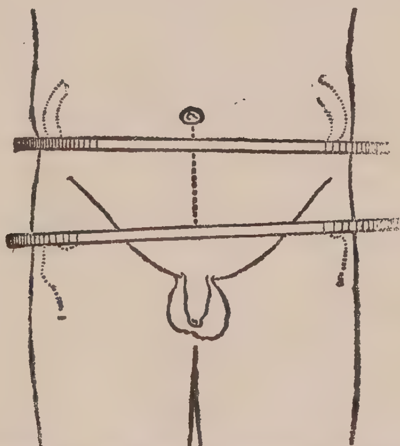


Fig. 97.—Method of ascertaining level of great trochanters and degree of pelvic obliquity.

The history of the nature of the accident is therefore of great importance in diagnosis. In extra-capsular fracture, the history of a fall upon the trochanter, and the presence of thickening when it is grasped between the finger and the thumb, are generally sufficient to establish the diagnosis. *Raising of the trochanter* accompanies either form, although in the intra-capsular form, until the ligament softens, the raising may be very slight.

Tests for the Position of the Great Trochanter.—Lay the normal limb in the same position as its fellow. See that the pelvis is straight. When there is any pelvic obliquity, the lines drawn from one anterior spine to the other, and from the umbilicus to the symphysis pubis, do not intersect at right angles. Indicate the anterior superior spine and tip of the trochanter major on each side with ink; then take a couple of strips of stout sheet-lead, as recommended by Chiene, and lay them across the body, joining the above points. If the trochanters occupy the same level on each side, the strips will be parallel. Should

they have undergone any change, the direction will be at once obvious, and a conclusion may be drawn as to the nature of the injury. For a similar purpose we may use Bryant's triangle. With the patient lying supine, indicate the anterior superior spine and the tip of the great trochanter. Join the points by a straight line. From the anterior superior spine drop a line vertically towards the ground, and from the tip of the great trochanter draw a line horizontally (in the patient's position) to meet the first line at right angles. The horizontals denote the amount of shortening if compared with similar figures on the normal side.

Crepitus should not be looked for, lest impaction should be undone in the one case, or some reflected portions of the capsule which carried blood-vessels should be torn in the other. *Eversion* occurs in both forms of fracture as well as in a mere bruise of the hip.

In intra-capsular fracture there will be the history of a twist or jerk of the neck of the bone, often the sound of something giving way ; then sudden inability to use the limb, and the patient falls to the ground. The diagnosis is often best arrived at by exclusion.

Extra-capsular Fracture.—This is much the commoner form of the two. Bony union with eversion and some shortening takes place almost invariably ; but frequently the patient is crippled, not from this, but from the ankylosis of the hip joint which results from the long period of immobilisation which has been enforced.

In relatively few cases in which this fracture occurs in men still able for active work, benefit often results from undoing the impaction, if considerable, under an anæsthetic. The limb is then treated in an abducted position, and massage applied to the joint and muscles.

Lucas-Championnière trusts to early movement in this fracture more than to massage. He fears that massage over the large veins in old people might set free a clot, and so he confines the massage chiefly to the posterior aspect of the hip. If there is much muscular spasm, and especially if the impaction has become loosened, extension of the limb with weight and pulley is advisable, but it need not be continued for more than from ten to fourteen days. No splint should be used, only sand-bags to steady the limb. Massage of the posterior and outer aspects of the hip may be employed daily or every few days. After a period varying from five to fifteen days, the patient should get out of bed and should move about a little on crutches, with an assistant on each side, at first at least. The sound foot should be raised with a high heel. Gentle swinging movements of the thigh should be encouraged, the range being increased as strength returns. Active movements of the foot, ankle, and knee should be made after the first day or two. The patient cannot bear weight upon the injured limb until eight or ten weeks have elapsed.

Intra-capsular Fracture.—Professor Lucas-Championnière does not discriminate this from the extra-capsular form in his account of the treatment. In view of the progressive shortening which takes place after the capsular ligament has given way, extension with weight

and pulley is advisable for three or four weeks, if the patient's health permits recumbency for so long. A Thomas's *hip* splint should be worn in bed for about the same time, and the limb steadied with sand-bags. Massage, as indicated already for the extra-capsular form of fracture, should be employed, but not passive movement, at least for several weeks. The patient may be raised in bed almost from the first, although the bed will be tilted up at the foot in order to provide counter-extension. The stages in the progress should be similar to those of the extra-capsular form, but from two to four weeks later.

If there is no union at the end of ten or twelve weeks, the patient must depend on bearing his weight upon ligaments which will grow stronger as time elapses. A firm belt round the pelvis, extending below the trochanters, will be helpful.

Prognosis depends largely on the age and strength of the individual. In the case of old people, where the fracture is frequently intra-capsular, prognosis should always be very guarded. An attempt at treatment should be made. It fails where the strength or condition of the patient cannot stand the demands of the confinement required. The chest should be examined; and care as to the state of the circulation, and renal secretion, may save much initial trouble. The difficulty attending expectoration in bronchitis, the tendency to hypostatic congestion, and the embarrassment to breathing, swallowing, defæcation, and micturition, which attend the dependant position of the patient's body, have to be combated, till there be some degree of tolerance to the new state of affairs. The administration of digitalis, ammonia, and bark; the use of enemata, the catheter, and massage of the body will do much to improve the general condition, but in feeble old people we are content with a false joint and get them out of bed into a chair rather than court a dangerous attempt at bony union.

Fracture of the Shaft just below the Lesser Trochanter.—This generally occurs in old people as the result of a twist, and the line of fracture is often oblique. Fortunately the injury is a rare one, for it is probably without exception the most difficult fracture in the body to treat satisfactorily. The upper fragment, short and sharp-pointed, is forced forward by the powerful psoas and iliacus muscles, while the lower fragment is drawn up behind it by the hamstrings and adductors. An immediate operation to secure the ends together would be the best treatment if the circumstances permit.

As regards apparatus, a double-inclined plane is advisable to keep the hip and knee joint flexed, while traction with weight and pulley is applied to the thigh. A Hodgden's splint is strongly recommended by many surgeons. The surgeon will be fortunate if he can keep the ends of the bones in apposition, even with considerable over-riding. The muscles for which the soothing effect of massage is most needed (psoas and iliacus) are out of reach.

Fracture of the Shaft of the Femur is caused both by direct and indirect violence. Diagnosis is generally easy from the distortion and unnatural mobility. The patient is not able to lift his leg on

account of the pain so produced, which is due to the distortion at the seat of the fracture.

Treatment.—The limb should be steadied and extended by an assistant, while massage is applied to the upper part of the thigh. If the broken ends do not come into good apposition, a general anæsthetic should be administered, and while the patient is going under, the seat of fracture should be supported with splints. Extension plasters should be applied from the lower part of the thigh to the ankle. The amount of weight will depend upon the muscular development of the individual, and will vary from about 9 to 30 lbs. or more.

The shaft of the bone must be supported by local splints. The most convenient material for this is Gooch's splint, applied in two or more pieces, so as to surround the thigh. Sand-bags should be used to steady the limb and to prevent rotation outward of the lower fragment, but in the case of unruly or restless patients the addition of a long splint is advisable (see Fig. 99).

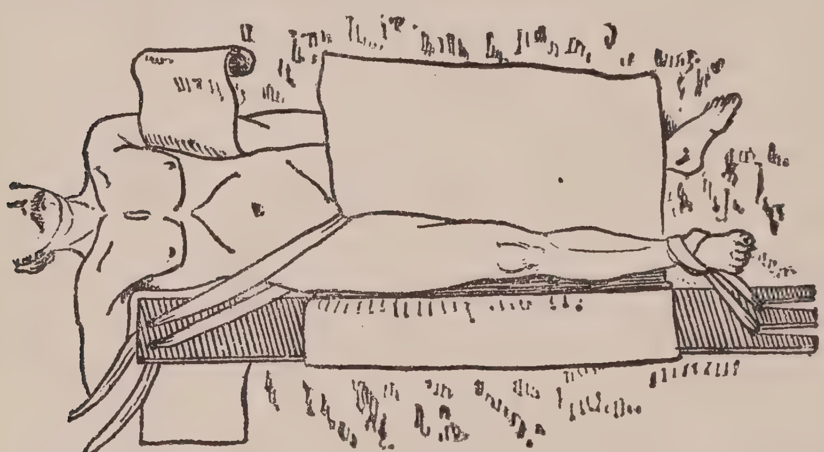


Fig. 98.—The Long Splint, showing the sheet, thoracic binder, and the perinæal band.

The Long Splint with Extension.—In using the long splint with extension, the following articles are required :—

Materials.—Extension plaster and tapes ; three Domet bandages : a splint 4 inches broad, of suitable length, to extend from the axilla to beyond the foot, and a sheet ; safety-pins ; a broad Domet roller for the chest ; a foot-piece for the long splint ; fine wadding ; bed props ; weights, cord, and pulley.

Apply the extension plaster as described (Chap. xxi.). Roll the splint in the sheet or tablecloth, leaving enough free to envelop the limb ; lay it alongside the patient, and slip it under the leg as in Fig. 98. The loose end is then folded over ; the weight for extension adjusted, and the bony prominences being suitably padded, the sheet may be secured to the splint with pins (Fig. 99). The thoracic binder is now passed under the patient (Fig. 98) and pinned. Finally, raise the foot of the bed as in Fig. 100.

The Long Splint with Perinæal Band.—It sometimes happens, owing to the form of the bed or other circumstances, that extension with weight and pulley cannot be carried out. We may then employ the long splint with the perinæal band. With this a couple of large handkerchiefs folded *en cravatte* takes the place of the extension apparatus. The splint and sheet are laid in position as formerly. The surgeon next secures one handkerchief to the foot (Fig. 98), and passes the other round the perinæum, so that the two ends may be through the holes in the top of the splint. He next secures the foot to the end of the splint, and now pushing it downwards, firmly with his hand, thus makes extension at the foot, while he maintains counter-extension from the perinæum by tying the top handkerchief (Fig. 101). Obviously before long the tension relaxes as the handkerchiefs give. The perinæum is apt to suffer and become excoriated; hence, although good results have been obtained with the long splint and perinæal band, the weight and pulley method is far superior.

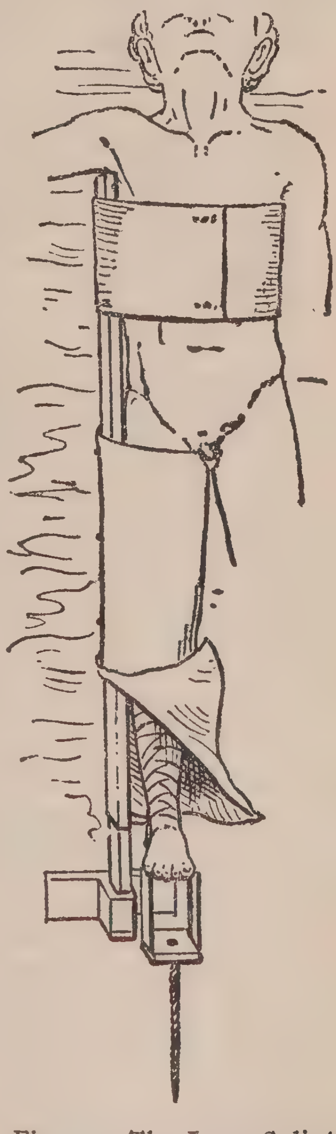


Fig. 99.—The Long Splint used with Extension.

After three or four days the splints should be taken down, and while the limb is steadied and extended by an assistant, the thigh should be massaged and the knee joint gently flexed. Massage should be repeated every three or four days, or oftener if there is much pain. One great cause of after-trouble is stiffness of the knee resulting from adhesions between the quadriceps extensor and the seat of fracture. For this reason, passive movement of the knee is begun early, and after about fourteen days the patient may move his knee voluntarily from time to time during the day.

Dagron finds that union takes place in about eight weeks. When the patient begins to use his limb, the thigh should be supported by splints, the knee and hip joint being free. A slight amount of weight put upon the bone hastens solidification, but the strain should be cautiously increased. Owing to the risk of an apparently firm callus yielding under the patient's weight, there is a great advantage in the

use of a Thomas caliper knee splint (p. 233) when the patient first begins to go about. Failing that, crutches should be used. Under the massage treatment the patient can frequently lift his extended leg off the bed in about three weeks, but he is seldom able to be out of bed under eight weeks. As the patient gains confidence he may dispense with one, then both crutches, and afterwards use only a stick, until he can walk unaided.

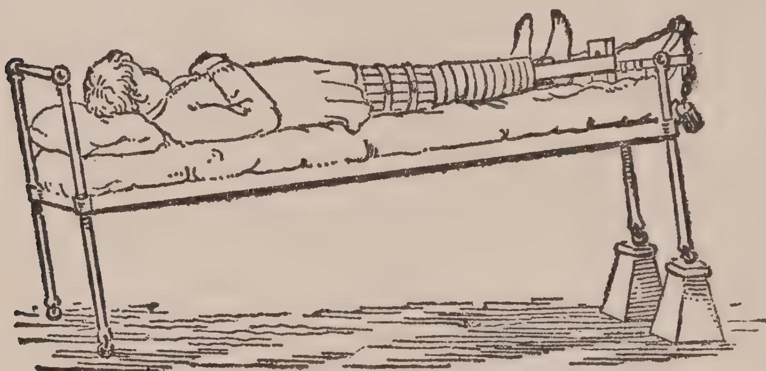


Fig. 100.—Extension by Weight and Pulley.

Fracture of the Femur in Children.—It is noteworthy, as stated before, that in children fractures of the femur are more frequently met with than fractures of the leg-bones; they are usually more or less transverse. Children are not easily kept quiet or dry, and therefore treatment is complicated by two conditions, unrest and moisture. We meet these difficulties by using the double long splint, or vertical

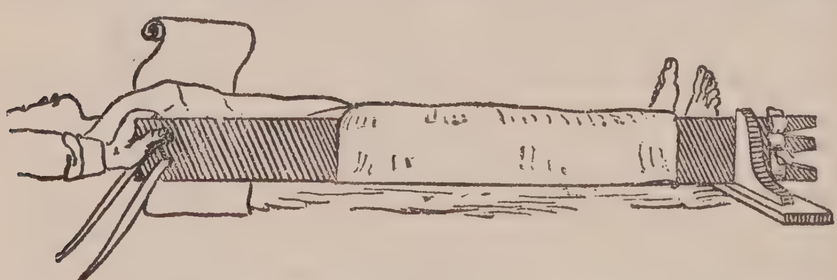


Fig. 101.—The Long Splint, showing how it must be pushed down in order to obtain extension before securing the perinæal band at the upper end.

extension (Figs. 102 and 103). The double long splint is, moreover, well suited for restless adults. It may be used with or without extension.

For fractured femur in infants Robert Jones recommends a Thomas knee splint applied as follows:—

"Extension plasters are applied to the leg below the fracture, and the limb is passed through the ring, which encircles the thigh at the groin, and which is padded over with felt, leather, and impervious

oilskin. The thigh is pulled, and the extension is maintained by the plasters which are affixed to the lower end of the splint (Fig. 104, *c*). A bandage is placed round the limb, and no further treatment is

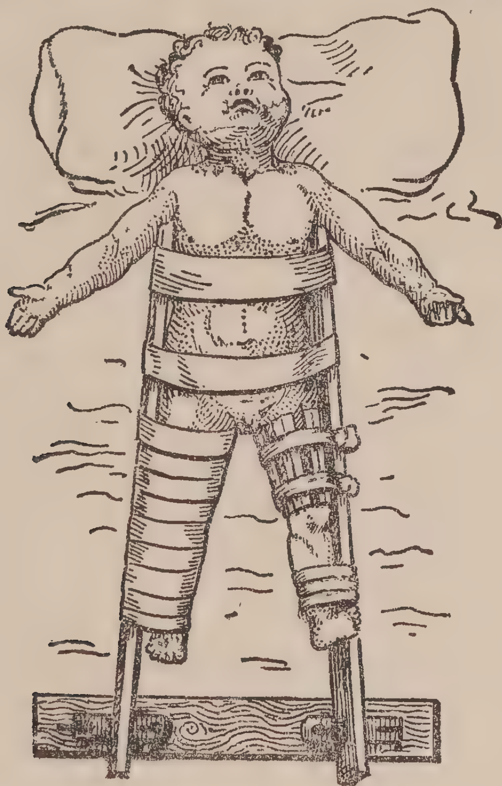


Fig. 102.—Double Long Splint.

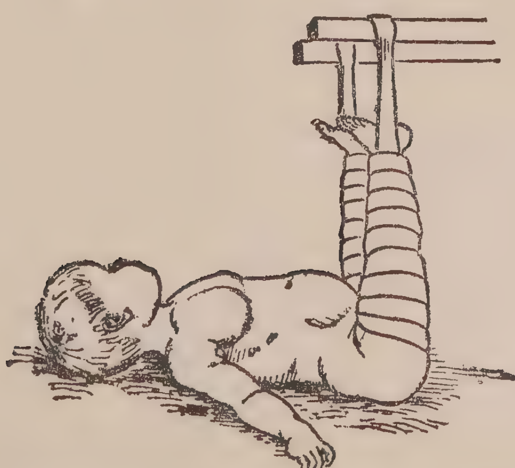


Fig. 103.—Vertical Extension for Fractured Femur in Children.

needed than now and again to extend the limb by pulling at the plasters. The little patient can be carried, nursed, left to play on the floor, and no displacement of fragments is possible. It can be applied easily in five minutes, whether the child struggles or not, and an anæsthetic is never needed" (Figs. 104, *a*, *b*, and *c*).

Fracture of the Femur above the Condyles.—The diagnosis may be made from the unnatural lateral mobility and crepitus a little above the knee, on attempted movement. Distortion may be masked by the swelling at the knee. A general anæsthetic should be administered, and if the position of the fragments is doubtful an X-ray photograph should be taken.

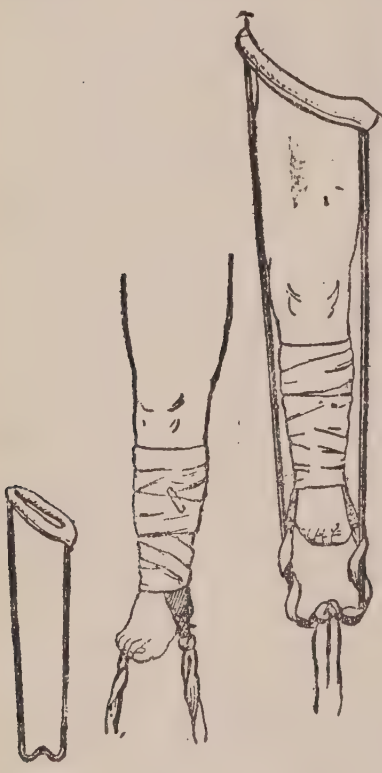


Fig. 104.—Thomas Knee Splint for Fractured Femur (*after Jones*).

Treatment.—The special difficulty in treatment in this fracture is due to the backward displacement of the lower fragment by the gastrocnemius muscle; but the hamstrings also tend to cause overriding. Fix thigh, knee, and leg in the flexed position upon a MacIntyre or similar splint. Should this method fail to ensure a good position, the tendo Achillis should be divided and the limb treated in the straight position. Extension of the leg by weight and pulley would also be useful. Massage of the muscles of the thigh and of the knee joint should be carried out daily. Passive movement must be reserved until pain and tendency to spasm have passed off. In about a week it may be cautiously begun, while the seat of fracture is steadied, care being taken that any movement produced takes place at the joint and not at the seat of fracture.

Fracture of the Femur into the Knee Joint.—This is the result of direct injury; either condyle may be broken off, or the fracture may be T-shaped. The diagnosis is as in the last case.

Treatment.—Careful massage of the thigh and knee joint; then the joint should be steadied with splints in a slightly flexed position, while extension with weight and pulley overcomes the disturbing influence of the muscles which act upon the knee joint. Passive and active movements must be used as soon as the pain and muscular spasm have sufficiently subsided, probably about the fou th or fifth day. Afterwards the sittings for massage and movement may be continued, at first daily, and then at ıonger ıntervals, the range of

movements being gradually increased. Traction should be discarded as soon as the fragments will remain in position without it, generally in from fourteen to twenty-one days. An operation may be called for when the fragments cannot be properly reduced by manipulation.

Fracture of the Patella.—Caused most frequently by muscular action; sometimes by direct violence. The *diagnosis* is made from the history, from the great swelling without adequate cause other than that of a fracture, from the patient's inability to lift the leg from the bed, and from the presence of two separate parts of the patella, probably without crepitus, as blood-clot generally covers the broken surfaces.

Treatment.—The most rapid and the most complete return to functional usefulness is given by immediate operation, clearing out clots from the joint, and wiring the broken surfaces of bone together. On the other hand, there is probably no fracture in the body in which the risks to the patient's life and limb are greater than in that of the patella, if the wound should become septic. For this reason the majority of the surgeons prefer non-operative measures, and those who do operate upon vigorous patients, decline to do so when the patient is old or unhealthy. Fibrous union, which is all that can be counted upon without operation, gives in most cases a good useful limb, and a fibrous union about 1½ or 2 inches, or even longer, is preferred by some to shorter, or a partially bony union which is apt to give way. The most serious obstacles to functional usefulness are adhesions in the joint and between the upper fragment and the surrounding parts. These can be obviated to a large extent by massage and early movement. Wharton Hood after three or four days' massage applied a strip of adhesive plaster 3 inches wide round the lower third of the thigh, and made his patient get up and walk about with the aid of a stick, renewing the plaster as it became loose. Tilanus advises the patient to walk in from six to twelve days, and Lucas-Championnière agrees with him. All advocates of the massage and movement method unite in condemning the older appliances, in which the joint was rigidly fixed in an extended position for several weeks, and they have abandoned the various devices which are intended to bring the broken surfaces together.

For the first few days the limb should be steadied in a splint with the knee in the most comfortable position, probably that of slight flexion in a MacIntyre splint, or a gutter splint made of Gooch's splinting or pasteboard. The splint may be steadied with sand-bags. When pain has subsided, the limb may be left free in the bed. From the first, the muscles of the thigh and the knee should be well massaged daily, to reduce the swelling and subdue spasm. When the massage is finished, the knee should be gently flexed. Lucas-Championnière finds that a very slight range of movement suffices to keep the joint supple, and he thinks it an advantage, therefore, to allow the leg to lie free in bed as soon as the patient can comfortably do without support. While the foot rests on the bed, the patient may flex the thigh, and this flexes the knee. Dagron advises that semi-flexion

should not be exceeded before the fifteenth day. The upper fragment should be steadied by the surgeon's hand, while passive movements are being carried out, and the range of movement should be cautiously increased. As soon as possible the patient should be encouraged to walk on his leg. A light posterior splint to support the joint in the efforts to walk would provide security against the knee giving way. Although the range of passive movements can be extended by degrees, the weight of the patient's body must not be thrown upon the uniting structures for several months.

Patients for whom it is important to be allowed out of bed soon can be treated with an ambulant splint in the form of Thomas knee splint with great advantage.

Fracture of both Bones of the Leg.—If the displacement cannot be reduced after the muscles have been soothed by massage, the patient should be anæsthetised in order to facilitate free manipulation of the broken ends of bone while the muscles are relaxed. Only in a small proportion of cases will operation be required on

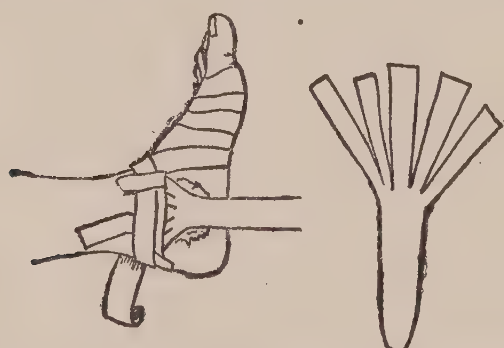


Fig. 105.—Fan-shaped Plaster for Extension.

account of the entanglement of soft parts or of great displacement of the broken ends, not otherwise remediable. When mere overriding from obliquity in the line of fracture is the cause of marked deformity or endangers the skin, extension upon the foot by weight and pulley for a week or two should be employed (Fig. 105).

Application of Splints for Fracture of the Bones of the Leg.—(a) *First Method—In the Extended Position.*—For all fractures of the leg, there is no apparatus of such universal application as the **Box-splint.**

Materials.—Two splints of light wood, ¼ inch thick, 4 inches broad, and long enough to extend from above the knee to a hand's-breadth below the sole. Three towels; one large, and two somewhat smaller. Slip knots; bandage; wadding.

Treatment.—Roll the splints in the two ends of the largest towel, and, fitting them on the sound limb, leave sufficient space for it between the splints. Raise the broken leg, and set the fracture,

slip the splints underneath the limb; raise the two sides of the box, and retain them in position with the hands. It is now an easy matter to insert pads where necessary, especially above the malleoli, under the tendo Achillis and near the knee. The two smaller towels are next folded so as to equal in length rather more than half the anterior aspect of the leg. They are then laid over the shin-bone, and all is secured by the three slip-knots (Figs. 106 and 107). The foot is bandaged, and the figure-of-eight turns around the ankle ensure that the foot is at right angles. Finally, when necessary, the extension is adjusted. With the box-splint one can at once see whether the foot is at right angles or not, and to what extent rotation outwards exists. The tendency of the heel to pass backwards can be largely avoided by the use of a substantial ring-pad.

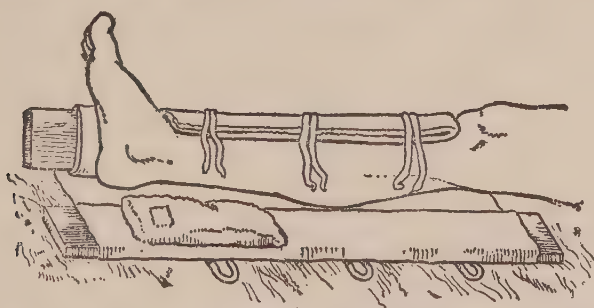


Fig. 106.—The Box-splint, showing arrangement of Anterior and Lateral Pads.

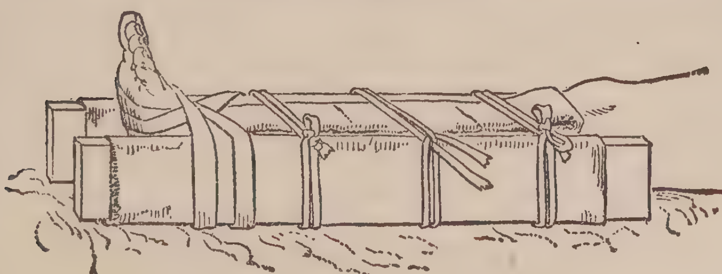


Fig. 107.—The Box-splint applied.

(*b*) *Second Method—In the Flexed Position.*—Many surgeons believe that the position of flexion is one in which a broken leg may be treated with most advantage. The principle of relaxing the muscles to prevent spasm is an old and good one, but the merits of extension are greater. One may, however, easily conceive cases and circumstances where the flexion method is preferable. By flexing the leg and swinging it in a cradle, or laying it on its outer side, the hamstrings and gastrocnemius are relaxed, and the heel is kept at rest.

Various Forms of Splint.—In ordinary fractures, lateral splints of wood or pasteboard are used. They should be shaped to fit the limb (for pasteboard, see Chap. xx.). If of wood they may be cut short at the level of the instep; the *outer* should have a foot-piece; if

made of pasteboard, both had better be provided also with a sole plate. Wooden splints should be perforated at the malleoli, to avoid pressure. The foot-piece of the external splint should be well padded towards the toes. After setting the fracture, the splints are buckled or bandaged on, and the limb, laid on its outer side, is secured by slip-knots to a pillow (Fig. 108). In this way pointing of the toes is

Fig. 108.—Application of Lateral Splints—Limb flexed and laid on its outer side.

readily prevented, but eversion of the foot cannot be so readily counteracted. If, however, two lateral splints of wood or pasteboard, each with a foot-piece, be fitted on, and the leg be now suspended from a **Salter's cradle** (Fig. 109), one can easily see if eversion is thoroughly corrected or not. In cases where backward displacement

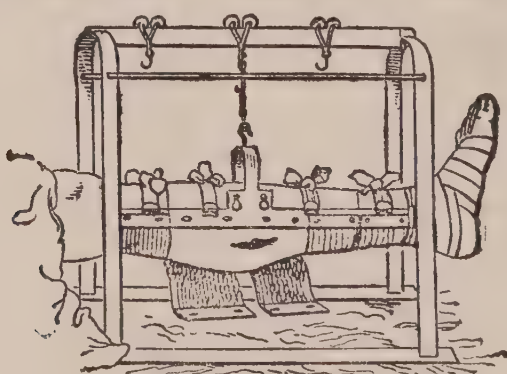


Fig. 109.—Limb slung in Salter's Cradle

of the heel does not readily yield with the ordinary **box-splint,** advantage may also be taken of the swinging position.

At first, while the muscles are inclined to contract in spasm, the patient will be relieved if the foot, as well as the seat of fracture, be supported. After a few days there will be an advantage in allowing **free play to the ankle, so that the** patient may spontaneously move

the foot from time to time between the surgeon's application of massage and movement. Hence, a supporting splint which can be employed with or without a support to the foot will be best, but one with a fixed foot-piece which can be easily taken down for massage will serve the purpose very well. In about three weeks there is generally so little tendency to displacement that the limb may be allowed to lie in bed unsupported, or steadied only by lateral sand-bags. At this stage the patient may be allowed out, going about on crutches with lateral pasteboard or poroplastic splints which do not confine the knee or ankle joints. In favourable cases weight can be borne on the fractured leg in about six weeks.

Pott's Fracture of the Fibula.—*Treatment.*—Where there is not much displacement, the limb should be well massaged, especially along the outside, to soothe the spasm of the peronei muscles. The patient should then by voluntary effort try to assist the surgeon in restoring the foot into position. The limb should then be again massaged and steadied with a Dupuytren's or a "box" splint, or any of the forms of leg splint which have a foot-piece. The splint should be removed for massage and movement daily, and at each sitting the foot should be brought nearer to its proper position, if it has not retained its position since it was replaced on the previous day. If the restoration is not complete on the first day, it will be better the second, and so on until it remains in position without difficulty. After about a week or ten days, the tendency to displacement will have passed off, and the patient will be able to move the ankle in all directions, with only a steadying hand placed over the malleoli. In from fourteen to eighteen days, if there is continued progress, the patient may be allowed to rest in bed with his foot tied in a pillow or quite free, and in about three weeks a supporting splint of plaster of Paris, poroplastic material, or pasteboard should be bandaged to the outside (or on both sides if required), and the patient should walk about with the aid of a stick. The surgeon must watch the effect of the patient bearing weight on the injured foot. If there is outward displacement, the treatment in bed must be continued, and the parts allowed to become more secure in their normal position before walking is attempted. In most cases provision against outward yielding of the foot should be made by raising slightly the inner side of the heel and sole of the patient's boot (see Fig. 110).

In cases in which the displacement outwards and backwards is very marked, the ligaments are more extensively torn, and the muscular spasm is sometimes so great as to endanger the vitality of the skin over the inner malleolus. If careful massage, aided by the patient as before, does not suffice to obtain a marked improvement in position, a general anæsthetic should be given and the deformity reduced. The leg should be fixed in a Dupuytren's splint and laid on its outside with the knee flexed; or preferably the foot and leg may be laid on an outside straight or gutter splint (Cline's) with thick padding under the outside of the foot, and steadied there with a bandage. Massage should be performed daily, and after the muscles

have been soothed the foot should be guided into position until it can be inverted by the patient's own efforts, supplemented by gentle traction by the surgeon. The subsequent treatment is similar to that described for cases with slight displacement, with the difference that the stages are more prolonged. When the tendency to displacement remains after six or seven weeks of treatment, besides having the inner side of the boot raised, the foot should be strapped to a steel carried along the outer side of the leg and fixed into the heel. The steel must be bowed opposite the outer malleolus if the skin there is tender. To the steel are fixed straps which draw the foot and ankle outwards when the patient bears weight on the foot (Figs. 110, 111, and 112). Sometimes the posterior lip of the lower articular surface of the tibia is broken off. The foot will then slip backwards very easily. Extension of the foot with a weight should

Fig. 110.—Right boot with heel skewed, and raised on inner side (*after Jones*).

Fig. 111.—Steel support which fits into outer side of heel (*after R. Jones*).

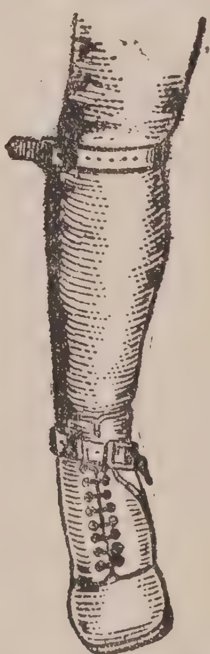


Fig. 112.—Right leg of foot, showing strap supporting inner side of ankle, and inner edge of foot raised (*after R. Jones*).

be tried, and failing success with that, an operation will have to be considered.

Splints for Pott's Fracture.—Special splints are sometimes used in the treatment of Pott's fracture and allied conditions, although as a rule such injuries are equally amenable to the box-splint. (*a*) Dupuytren's splint is applied so as to counteract eversion and fix the foot. Although originally plain, as now often modified, it is a long splint in miniature (Fig. 113, A), and is applied with the aid of a bandage, slip-knot, and towel. Fold the towel, lay it against the inner aspect of the splint, and fold up the surplus (as in Fig. 113, A) to form a pad. Split the ends of the bandage and fasten them through the two holes at the end of the splint; bring it down over the towel, and secure all with slip-knots (Fig. 113, A). The splint is now mounted. Set the fracture. Lay the splint along the inner aspect of the leg. Secure it to the leg below the knee with a slip-knot, and then proceed to incorporate splint and limb by four or five figure-of-eight turns

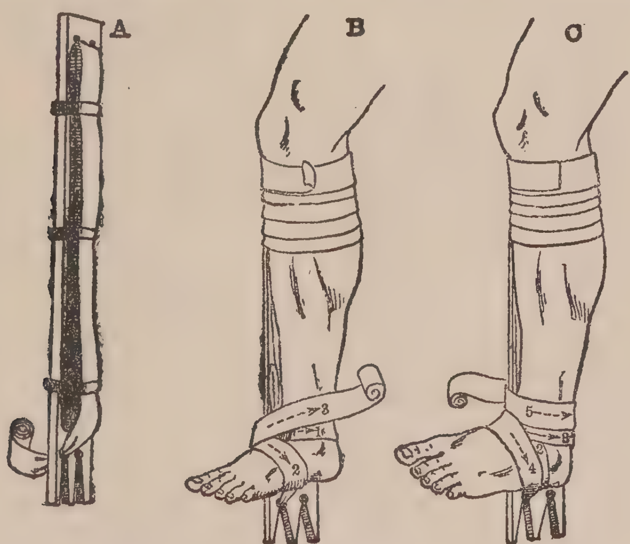


Fig. 113.—Dupuytren's Splint—A, Ready for use; B, Fixation to Limb; C, Method of producing Inversion of the Foot.

(Fig. 113, B). By so doing, the foot is also fixed at right angles. As the bandage now travels from over the outer aspect of the foot, it should be carried between the forks of the splint, and from that should pass over the front of the ankle round to the back, embracing the splint.* Complete the new series of figure-of-eight turns, by once more reaching the front of the ankle, and descend over the fifth metatarsal to the forks. By this manœuvre, the foot is forcibly inverted, and the displacement caused by the accident remedied (Fig. 113, C). The splint should be firmly secured before the latter figure-of-eight turns are made, so that the heel is well fixed against the splint, which must on no account be allowed to slip towards the

* *N.B.*—The turns round the ankle should be kept low, so as not to press on the seat of fracture or resist the effect produced by the firm inversion of the foot.

instep. In correcting eversion, the loops of bandage should act through the medium of the fifth metatarsal. Finally, the leg is laid on its outer side on a pillow.

(*b*) In case of Pott's fracture with marked tendency to backward displacement of the heel, an anterior *horse-shoe splint* has been used. It should be well padded to avoid pressure effects. Its application is illustrated by Fig. 114, where the tip of the heel is seen to rest in the handkerchief.

The MacIntyre Splint is extremely useful in all severe injuries of the foot, leg, and lower part of the thigh. It consists of a trough

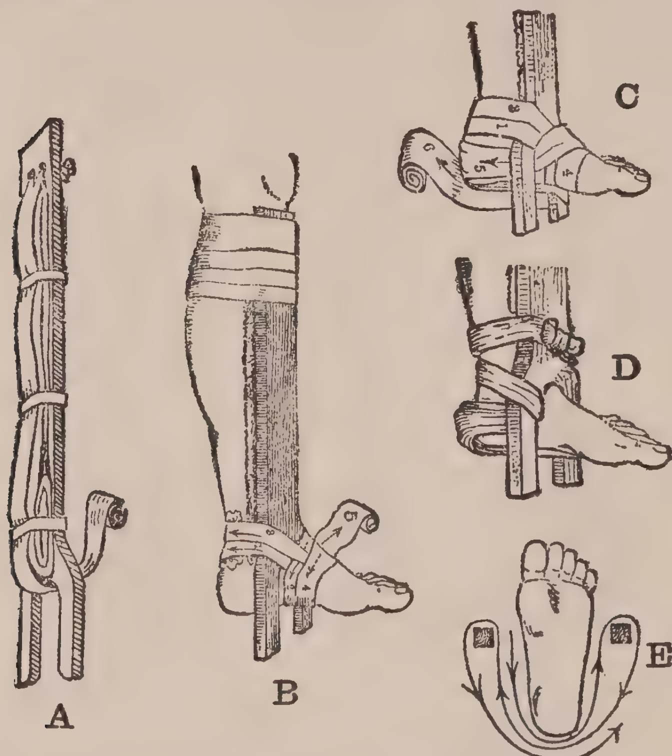


Fig. 114.—The Horse-shoe Splint—A, Ready for use; B, Fixation to Limb; C and D, Method of supporting the heel with a bandage; E, supporting the heel with a handkerchief.

of sheet iron for the thigh, and one for the leg, both being hinged together, and kept at any required angle by means of a screw. A foot-piece, which may not only be fixed at any angle to the leg-trough, but which—working in slots—may be slid for a certain distance up and down it, is an important part of the whole. The foot-piece has a concave ending, and is provided with a button for the purpose of giving attachment to a stocking or bandage, which at one time was used for drawing forward the heel (Fig. 115), although few surgeons now employ this method.

Before the splint is applied, the distance from the foot-piece to the

knee-bend must be accommodated to the length of the patient's leg, and the necessary angle of the thigh- and knee-parts determined upon.

Folded linen sheets, cotton wool, or other padding, must be laid on the trough, and the hollow between the lower end of the leg-trough and the foot-piece filled up by transverse pieces of bandage.

When the leg has been laid upon the splint, the surgeon begins by fixing the foot with turns of bandage, ensuring comfort by plentiful padding on the dorsum, below the heel, and under the sole of the foot. Then, with a roller bandage, he fixes the limb to the leg- and thigh-troughs. Some make the patient wear a sock, to the toe of which a tape is fastened; this being brought over the concave end of the foot-piece is fixed to the button before noticed.

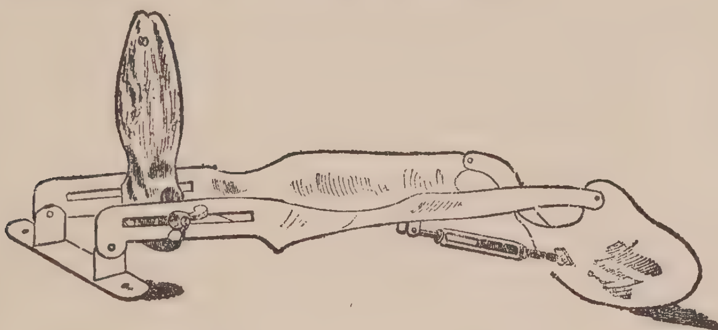


Fig. 115.—The MacIntyre Splint

Fractures of the Tarsal Bones.—The bones most frequently fractured are the astragalus and the os calis. The causes are, falls on the heel, crushes, and twists. Diagnosis will be made from the history of the accident, from distortion of the foot, and from crepitus elicited by careful manipulation. An X-ray photograph is important.

Treatment.—Rest in bed, massage, and movements carried out on general principles. An operation will be advisable when, for instance, the bony portion of insertion of the tendo Achillis is torn off, or when the broken astragalus becomes displaced and hinders the proper use of the joint.

Fractures of the Metatarsal Bones occur as the result of direct injury, or from marching, or dancing. Diagnosis is based on the history, the presence of swelling, pain, tenderness, and crepitus.

Treatment.—Rest and massage.

General Remarks.—Fractures of the leg are usually united in from four to six weeks. Prior to this period they may be, however, put up in starch or plaster of Paris, and the patient may leave hospital on crutches. Or, again, the ambulant method (p. 315) may be used from the beginning of treatment. Some œdema itching, muscular and joint stiffness are frequently met with after fracture of the bones of the leg, and may be very persistent. There can be no doubt that the careful reduction of the injury and the early use of massage (p. 207)

tend to render such complications less, and, moreover, restore the limb sooner to a normal state. In the same manner the ambulant treatment tends to a more early use of the limb.

Before the days of extension, fractures of the femur were frequently treated in the flexed position. Such forms of apparatus as Earle's bed were made use of when there was marked displacement, as occurs after fracture below the lesser trochanter or above the condyles. By means of a general anæsthetic and extension, we now get over the muscular spasm, nor is it often necessary to divide the tendo Achillis, as has been sometimes recommended to meet the last-mentioned instance. When patients have to travel a distance, and a temporary dressing is made use of, lashing the flexed limbs together to a pillow is often advantageous.

CHAPTER XVI.

ON FRACTURES (*Continued*).

Contents—D. Fractures of the Spine, Ribs, and Pelvis.—(1) Spinal Injuries—Their Gravity—Immediate Treatment—Attendant Dangers—(2) Broken Ribs—(3) Fractures of the Pelvis—Possible Complications.

E. Fractures of the Head and Facial Bones.—(1) Scalp Wounds—(*a*) Compound Depressed and Punctured Fractures—(*b*) "Concussion" and "Compression"—(*c*) Fractures of the Base of the Skull—(2) Fractures of the Facial Bones—(*a*) of the Nasal Bones—(*b*) of the Upper Jaw—(*c*) of the Lower Jaw—Use of Antiseptics.

D. Fractures of the Spine, Ribs, and Pelvis.

(1) **Spinal injuries** are extremely grave, as the associated concussion, hæmorrhage, or sprain may lead to most serious inflammatory changes in the cord.

Fractures are of common occurrence, and are usually recognised by local irregularity and tenderness of the spine, and the sudden development of motor symptoms. The higher up in the spinal column the fracture or dislocation lies—thus affecting the cord—the greater will be the resulting paralysis; and conseqently respiration may be carried on by the diaphragm alone, all the other nerves save the phrenic being inactive.

Immediate Treatment.—In many cases a plaster jacket will give some relief applied in the horizontal position (see Chap. xxii.). In extreme cases the patient should be laid at once on a water-bed, and the site of the lesion, together with the condition of the bladder and rectum, ascertained. Defective innervation of the parts supplied beyond the seat of the lesion predisposes to trophic changes, bed-sores,

and inflammations. The greatest care must be exercised in drawing off the urine, which should be done at regular intervals with a disinfected catheter. The overflow of an over-distended bladder must not be taken for normal micturition.

Attendant Dangers.—The patient is specially liable to pulmonary troubles. Hypostatic congestion, bronchitis, and inflammation may prove speedily fatal, for he may have lost the power of coughing. Death from septic cystitis and surgical kidney is common, hence the value of urinary antiseptics. At points of pressure bed-sores arise: hence the use of cages to protect the toes, and the necessity for shifting the position daily to some slight extent, and keeping the patient dry (p. 166). Careful investigation and records should be made at intervals of the extent and nature of the paralysis—sensory or motor, etc., the condition of the various reflexes, and the existence or development of hyperæsthetic areas or zones.

Prognosis.—The slightest return of motor power within the first six months, any improvement in the cystitis which is so generally met with, or a more healthy condition and healing of the bed-sores, are favourable prognostics.

(2) **Broken Ribs** arise mostly from blows and squeezes, but may also be caused by violent muscular action on the part of the patient himself, as, for example, in coughing. The patient endeavours to keep the part at rest, and so abstains from taking a long breath, any attempt at which causes severe local pain. If the pleura be wounded, he would fain cough, but dare not do so. If the fragments have injured the lung, he may expectorate blood.

On manipulation, local tenderness is manifest, and crepitus may sometimes be made out; but too active endeavours to elicit this should not be made. The stethoscope may help; as a rule, the methods referred to on p. 145 are most serviceable; and the localised pain on pressing the rib at a distance from the injury indicates the site of fracture.

Where fracture exists, a species of plaster cuirass may be formed out of overlapping strips running from spine to sternum of the whole affected side. In doubtful cases it is always well to give support, and a Domet-roller, disposed in a series of sloping figure-of-eight turns around the thorax, will do what is necessary.

For great dyspnœa after thoracic injuries, bleeding has been used with benefit.

(3) **Fractures of the Pelvis** are common, as the result of severe crushes. The patient frequently suffers from shock.

Possible Complications.—The injury is of moment from the liability to damage of the pelvic organs, and hence the question must be asked: Has the patient made water or not? If he has not, a duly purified, soft rubber catheter, or failing that, a gum elastic instrument should be passed and the water drawn off. If any difficulty be met with and blood appear in the urine, the propriety of tying in the catheter may be discussed. This should certainly be done, if on inserting the finger into the rectum any irregularity of the pubic

arch denoting fracture be felt. When the urethra has been injured by fracture of the pelvis, the rupture is in the membranous urethra posterior to the triangular ligament and if extravasation of urine occurs, it will be intra-pelvic, perhaps unrecognised. and liable to do more damage than the familiar extravasation into the perinæum and scrotum, associated with rupture anterior to the ligament. If one cannot pass an instrument, it is probably better, meanwhile, to aspirate the bladder, and at the earliest possible opportunity put the patient in the lithotomy position, incise longitudinally, and, if possible, suture the ruptured channel, leaving in a tube to drain the bladder, posterior to the site of injury.

Prognosis.—If the bladder and urethra have escaped, fracture of the pelvis does not generally give rise to much anxiety. Examination from the rectum and along the crests of the iliac bones will reveal the line of the lesion. Rest in bed and fixation by a roller-bandage and pillows serve as treatment.

Treatment of the Fracture.—The general principles which have been laid down for the treatment of fractures elsewhere should be applied to the pelvis—*i.e.*, massage to the neighbourhood of the fracture—gentle passive movements to prevent stiffness of the hip-joint, and active movements, cautiously increased.

The patient should be in bed for from six to eight weeks; a bandage round the pelvis will be found a comfort for the first two or three weeks.

E. Fractures of the Head and Facial Bones.

All head injuries require consideration and care. From lack of attention grave results may follow the simplest lesions, and from want of observation important data may be missed. Wherever the skin is broken, the most stringent antiseptic precautions should be enjoined. They are absolutely essential when the bone is in any way injured. Should sepsis occur, there is practically no limit to the ulterior consequences, and these may vary from a local redness to a general meningitis.

(1) **Scalp wounds** are to be treated on general principles. Owing to the great vascularity, every shred of tissue that is not killed outright should be preserved. The hair should be shaved off, and everything most rigorously cleansed with antiseptics. By means of acupressure (p. 65) a more rapid arrest of bleeding may sometimes be obtained than by the use of ligatures.

(*a*) **Compound Depressed and Punctured Fractures** always require trephining—probably all simple depressed fractures should be elevated or treated in the same way. An exception may be made with young children, where, unless the symptoms are rapidly progressive and life is threatened, it is legitimate to delay, as the young and elastic calvarium usually rises.

(*b*) **Concussion and Compression.**—Whenever, as the result of a blow or fall, the patient has become unconscious, a guarded

prognosis should be given. Even if the patient have rapidly regained his senses, he requires exceeding care. The unconscious condition produced suddenly by an injury to the head is known as **concussion.** The patient in this state lies faint and listless, with a weak irregular pulse, and he can be often partially aroused. The breathing is shallow and weak. The pupils react to light and vary as to size. Recovery takes place gradually, and commencing reaction is frequently associated with nausea and vomiting.

Treatment.—Keep the patient warm and quiet. He must always be carefully watched, and stimulants should be avoided. Concussion may, however, go on to **compression**, or there may be an interval between the two. The patient now becomes gradually insensible, and cannot be roused at all. He sinks into a stupor and lies breathing heavily, with loud, stertorous, slow respirations. His pulse is slow and dragging; the sphincters are paralysed; urine accumulates; the eyes no longer react to light; the pupils are frequently dilated; the condition deepens, and he dies comatose.

Such a state of affairs calls for immediate action. An attempt must be made to remove the compressing agent—be it bone, blood, or inflammatory product. In cases where after a simple injury, with, it may be, only slight concussion, symptoms of compression develop, any delay in treatment may be fatal. Such cases are often due to rupture of the meningeal artery, and are characterised by the rapid onset of compression, associated with dilated pupil on the side of the hæmorrhage, and general paralysis on the other side of the face and body. Only immediate trephining can then save life. The condition of the pulse may mislead. In some instances it is rapid instead of slow and dragging. In all cases, absolute quiet, cold to the head, and counter-irritation (by means of croton oil purgation) is to be recommended, as well as bleeding behind the ears.

(*c*) **Fractures of the Base of the Skull** are characterised by the escape of cerebro-spinal fluid from the ear, or by bleeding from the ears, mouth, and nose, conjunctival ecchymosis, and occasionally by facial paralysis. Lumbar puncture has been used in diagnosis. In addition to general treatment, an attempt should always be made to combat septic meningitis by gently syringing the ear with 1·20 carbolic, dusting in iodoform, and plugging with antiseptic wool.

(2) **Fractures of the Facial Bones** present the peculiarity that they are frequently compound from involvement of the mucous membrane of adjacent cavities. However, they are not more dangerous on that account, since here sepsis is not so obnoxious, because of the great vascularity of the parts and because of the free drainage that is afforded when the mucous surface as well as the skin is wounded. The amount of damage is often veiled by swelling, which generally comes on with much rapidity; hence the sooner the patient is seen and his injuries recognised and treated, the better. Diagnosis is favoured by the examination which can be made from the nasal and oral cavities, as well as by external manipulation.

(*a*) **Fracture of the Nasal Bones** results from great violence.

The fragments must be raised from within by a probe, and the septum restored if need be with dressing forceps, as nasal plugs do no good. The patient must be cautioned not to finger the parts, nor to blow his nose violently for a week. If retention is difficult, it is better to give an anæsthetic, and skewer the elevated broken bridge with a stout steel pin.

(*b*) **Fracture of the Upper Jaw.**—When the upper jaw is broken, the alveolar margin is usually interfered with, and loose teeth require attention. None should be removed unless they are broken, or their alveoli hopelessly destroyed. Otherwise, they should be replaced, the bone modelled into shape, and the lower jaw bound to the upper by means of a split bandage (Fig. 116): the opposing teeth act as splints. The patient is enjoined absolute quiet, and fed with slops by means of a tube carried from the mouth behind the last molar, or through a dental gap, or from the nose.

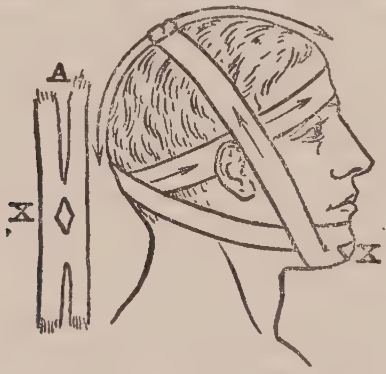


Fig. 116.—A, Four-tailed Bandage for Fracture of the Jaws; X, Aperture for the Chin.

As a general rule, injuries of the face implicating the malar bone and jaw are severe and complicated with laceration of the soft parts, but are generally hopeful. Every fragment should be retained and sutured, coagula removed, the parts purified, dusted with iodoform, and treated as special circumstances require.

(*c*) **Fracture of the Lower Jaw.**—When a patient has sustained a violent blow on the lower jaw, and he is bleeding from the gums with loosening of teeth, care should be taken not to overlook the possibility of fracture. It is well then to grasp and steady one-half of the jaw firmly, and to make forcible movement of the other half in various directions, as it sometimes happens that the fragments interlock, and there is no evident displacement. When fracture is diagnosed, or well marked, and the fragments readily retained, a split handkerchief may be applied over a gutta-percha or pasteboard chin-cap. After-treatment is similar to that in fracture of the upper jaw. In more difficult cases, interdental gutta-percha or vulcanite splints, with aperture for feeding, can be applied, with the occasional aid of the dentist. Immediate wiring of the fragments is carried out with much success.

Use of Antiseptics.—In all fractures of the facial bones where mucous cavities are involved, marked benefit attends the use of antiseptic washes. Warm water, having Condy's fluid or boric acid added to it, may be used with a syphon, and frequent irrigation in this fashion gives the patient much comfort and prevents fœtor. A continuous purulent discharge denotes a local necrosis of bone, which requires removal as soon as it is loose.

CHAPTER XVII.

DISLOCATIONS, SPRAINS, AND BRUISES.

Contents.—Diagnosis and General Treatment—Special Treatment for **Dislocation** of the Clavicle—Shoulder—Elbow—Wrist-joint—Thumb—Phalanges—Lower Jaw—Hip-joint—Patella—Knee, Ankle, or Astragalus—Cautions necessary in old-standing Cases—Treatment of **Sprains** and Bruises.

Dislocations—Diagnosis.—It is obvious that the methods adopted to discover the existence of fracture are equally serviceable in the case of dislocation. As fractures are characterised by preternatural mobility at a part of a bone which is normally *rigid*, so dislocations show preternatural fixation of a *movable* joint, along with an abnormal relation of certain associated bony structures. Naturally the exceptions to this generalisation are many; and—more especially when we deal with impacted fractures in the vicinity of joints—there is sometimes a degree of doubt, only to be cleared away by careful observation.

General Treatment.—The behaviour of dislocations after reduction varies much. Where the adjacent bone-surfaces embrace each other closely, or are held in apposition by strong muscles or ligaments which remain intact, the tendency to redisplacement is not well marked; whereas, if the opposing surfaces be small and shallow, and the uniting ligaments be greatly destroyed, the slightest motion will bring about the dislocation afresh. This is well seen if we compare a dislocation of the shoulder or hip, with one of the clavicle or head of the radius. In reducing the dislocation, we may either by gradually increased and prolonged force weary out the resisting muscular structures, and so effect a cure; or, again, by means of manipulations which tend to relax the tense muscles, and by making use of the dislocated bone as a lever, we may cause the escaped articular end to retraverse the path it took in leaving its companion-bone, and so regain its normal position. Subsequent treatment consists in retaining the bones in position till the capsule heals, and using passive motion at an early date in order to obviate the formation of adhesions.

(1) **Dislocations of the Clavicle** occur at either end. They are usually replaced with ease, but retained with difficulty; they are amenable to treatment similar to that used in fracture of the collar-bone. Attempts should also be made by means of a pad to retain the displaced surface; for this purpose elastic bands, strapping, or a hernia truss have been recommended.

In dislocation at the acromial end, the arm should be supported in a sling at a right angle, and the separated surfaces kept in position by a few turns of elastic webbing, running round the shoulder and elbow, and passing under the opposite axilla as for fracture of the acromion process (see p. 154). The usefulness of the limb is not greatly impaired even where a good result as regards appearance is not obtained.

(2) **Dislocation of the Shoulder** may be made out from several features. The patient generally supports his semiflexed arm mid-

Fig. 117.—Reduction of Dislocation by Heel in the Axilla.

way between pronation and supination. The elbow is tilted from the side. The shoulder is flattened—not rounded, as on the normal side, and the level of the axillary border is lowered. If a measuring-tape be carried around the circumference of the axilla over the clavicle and acromium, it will be found that in dislocation there is an increase of from 1 to 2 inches, as compared with the opposite side. If the hand be lifted to the top of the opposite shoulder and held there, it will be found that no force can bring the elbow against the chest-wall. This test may fail in old-standing cases. The great proof of dislocation, however, is afforded by the change in the relative position of the coracoid process, the acromion, and the great tuberosity of the humerus. The first two must be identified; the last should be about an inch below, and outside the former two. If the articular cavity be empty, on rotating the elbow the head of the bone will be found anterior, inferior, or posterior to its normal site.

The varied forms of dislocation here are recognised more by direct observation as to the position of the displaced head. There is not much to be gained by measurements of the length of the limb.

Reduction—First Method—by Heel in Axilla.—Fix the shoulder-girdle and use extension, with the heel in the axilla. Lay the patient on his back on a mattress or cough (Fig. 117). Take a few turns with a wetted bandage just above the elbow; over this slip a clove-hitch on a laque (*i.e.*, three of four skeins) of worsted, and fix it with a few more turns of the bandage. The surgeon now removes his boot and places his heel in the axilla, fixing the border of the scapula with it, flexes the patient's arm, and makes steady traction, occasionally slackening off. When reduction is effected, he should manipulate the joint to make sure of his success. Good results are also gained

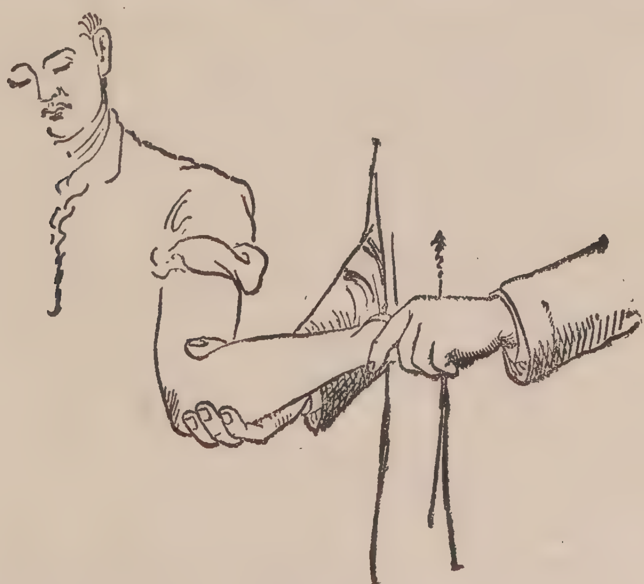


Fig. 118.—Kocher's Method—First Part. External Rotation of Humerus.

by extending the limb, and carrying it directly upwards. A similar mode is that in which the surgeon stands behind the semi-recumbent patient, fixes the shoulder girdle with one foot, and raises the arm above the patient's head.

Second or "Manipulation" Method of Kocher.—The so-called "manipulation" method of Kocher is performed by flexing the forearm to a right angle, and pressing the elbow to the side. External rotation of the humerus is then performed by pulling the hand outwards (Fig. 118). This movement must be carried out slowly and gently, and may occupy five minutes. The limb is now rapidly elevated directly forwards, and then rotated inwards, and the displaced bone slips easily into its socket.

In every case where this is difficult, chloroform may be given.

Third or Manipulation by Abduction and Rotation Inwards is strongly

recommended by A. G. Miller, who describes it as follows :—" The patient being seated on a chair, the surgeon stands at the injured side (say the right) and takes the arm in both hands ; one (the left) being above the elbow, the other (right) above the wrist, the arm being bent to an L at the elbow. An assistant stands at the patient's other side and steadies the scapula with both hands.

" The surgeon then gently and slowly elevates the arm, making traction outwards from the body, at the same time assuring the patient that what he is doing will not be very painful, and that it is not the actual reduction but merely a preliminary. If the patient should resist, then the surgeon may wait for a while or administer an anæsthetic.

" When the patient has ceased to resist, the arm will come towards the surgeon ; then is the time to rotate the humerus by dropping the

Fig. 119.—Kocher's Method—Third Part, the arm having been raised forwards, Internal Rotation is rapidly executed.*

hand, and the head of the humerus will glide into position."

Subsequent Treatment.—Rest the joint by means of supporting the elbow in a sling, and bind the limb to the side. Begin gentle passive motion at the end of ten days.

(3) **Dislocations of the Elbow** are most readily diagnosed by finding the condyles of the humerus, noting the relation of the head of the radius to the end of the olecranon condyles, carefully exploring the bend of the elbow, and noting to what extent movement is interfered with. In the common backward displacement of both bones, the cup-shaped head of the radius is readily detected posterior to the condyle, and the bend of the elbow is filled up with the projected extremity of the humerus. By hyper-extension, or extension and rapid flexion, reduction takes place ; moreover, this is not attended

* The humerus has been represented as slightly abducted. It should have been elevated directly forwards.

with crepitus, nor yet with redisplacement when support is withdrawn, as is so well marked in cases where the humerus is broken. After every reduction the surgeon must *fully flex the limb*, in order to satisfy himself that all is right. Treatment is then similar to that for fracture in the elbow-joint (see Fig. 120).

It sometimes happens that the radius alone is displaced, and its head is to be found lying in front of or behind the external condyle. In such a case the surgeon extends the forearm, supinating in the first form, and pronating in the second, to get the parts in apposition. A special pad should be bound over its head to retain it, and the elbow kept at rest for a longer period than in other dislocations.

(4) **Dislocation at the Wrist-joint** is easily recognised, and as easily reduced.

Fig. 120.—Reduction of Backward Dislocation of Elbow over the Knee.

(5) **Dislocation of the Thumb** is often very stubborn. By forcing the metacarpal well into the centre of the hand, fitting on the Siamese link, making extension in the direction of displacement, and then suddenly and forcibly flexing in the opposite direction, the ligaments and tendons may be so stretched that the reduction takes place. An excellent plan is to hyper-extend the thumb, and then push the base of the phalanx upwards and flex. The tendon of the flexor longus pollicis passes to the ulnar side, and sometimes requires to be unlocked by manipulation before reduction can be effected.

(6) **Dislocation of the Phalanges.**—When the phalanges are displaced, there is some little difficulty in getting a grip of the small distal extremity. The toy known as the "Siamese link" gives one a good purchase, or somewhat similar methods may be improvised.

(7) The rare condition of mallet or dropfinger is one in which there is more or less complete subcutaneous rupture of the extensor

tendon of the finger at its insertion, so that the terminal phalanx is displaced and the flexor tendon entangles over the head of the second phalanx. Replacement is effected by means of a splint, but operative treatment may in some cases be necessary.

(8) **Dislocation of the Lower Jaw.**—The recognition of this is simple in the extreme. The patient cannot close his mouth or articulate; the glenoid articulation is found to be empty; but the condyle may be felt at the eminentia articularis; the masseter and temporal muscles are tense. The condition may occur on one or both sides. For reduction, the patient sits on a low stool facing the surgeon, who lays his thumb on the last molars of the dislocated jaw, and places his fingers firmly beneath the patient's chin. He then forcibly pushes downwards and backwards with his thumbs, upwards and forwards with his fingers; and as he feels the jaw move, dexterously withdraws his thumbs as reduction is effected. The thumbs may be protected with a napkin. Subsequent retention and treatment are as in simple fracture of the lower jaw.

Fig. 121.—Reduction of Dislocation of Hip.

(9) **Dislocation of the Hip-joint** presents the marked feature of an inverted limb, when the head of the femur has passed backwards or upwards. If it lies forwards and downwards in the obturator foramen, the toes are pointed and the limb abducted and everted. In every case, the leg is so fixed, that attempts to straighten and flex up the knee or hip-joint are always associated with more or less of a rocking motion of the pelvis, which takes place through the lumbar vertebræ—as may be established if one lays his hand under the back, while he puts his patient through these movements. In direct displacement forwards, the head of the bone is readily felt out of place.

The posterior displacements are the more common. Reduction is most readily effected under chloroform. The patient is laid on his back, and as soon as he is deeply "under," the surgeon flexes the leg on the thigh, the thigh on the abdomen. Thus he relaxes the ilio-psoas and ilio-femoral band (Y-shaped ligament), and, moreover, causes

the head to descend and lie rather in relation with the rent in the capsule through which it emerged. He then, grasping the patient's ankle, circumducts the limb outwards and extends, and the head enters its socket.

If the dislocation be of the *ubturator or pubic form*, the first part of the procedure is similar, but the surgeon circumducts to the inside. As Professor Chiene briefly puts it:—"Where the head lies to the *outside* of a vertical line drawn through the acetabulum, circumduct *outwards* after flexion; if it lies to the *inside*, circumduct *inwards*."

It may happen that the head travels backwards and forwards between the obturator foramen and the region of the sciatic notch, in place of entering the acetabulum, while one attempts reduction. If the surgeon will, however, execute the movements, while he lifts the patient by the leg, as it were, it will be found that the head usually clears the rim of the cotyloid cavity, and becomes replaced.

After-treatment consists in tying the patient's legs together in bed, and putting on a pelvic band. If necessary a long splint may be used.

(10) **Dislocations of the Patella** are not unfrequently reduced by the patient himself. They are easily recognised, and yield to flexion-movements, combined with rotation and extension.

(11) **Dislocations of the Knee, Ankle, or Astragalus** are commonly compound.

Cautions to be observed in old-standing Cases.—Reduction of old-standing dislocations should not be lightly undertaken, and the whole circumstances of the case must be carefully reviewed.

Treatment of Sprains.—If seen immediately after the accident, the injured part should be held for a few minutes under a cold tap; the limb should then be raised, wrapped in cotton wool, and firmly bandaged, a splint being put on to keep the parts at rest. These measures aim at limiting the subcutaneous bleeding. The great pain which often follows a few hours after a bad sprain, especially when not treated at once, will be most relieved by hot fomentations, but as these increase the after-swelling, they should be limited, and as far as possible avoided. The pain which may appear eight or ten hours after the injury, and which may continue for a day or two, is due to inflammation, and is best treated by rest and elastic pressure, and by cold applications—such as an ice-bag, or a bandage or cloth wetted in cold water, or in an evaporating lotion, and exposed to the air.

As soon as acute symptoms have subsided, the swelling should be treated by firm elastic pressure and rest, with occasional gentle rubbing in the course of the nerves and lymphatic channels.

In most cases, simultaneously with the subsidence of swelling, gentle passive and active movements should begin. It may, however, be necessary for the joint to be supported for some weeks after the injury. The risk of chronic inflammation beginning should always be kept in view, especially in patients of a strumous constitution (see *Joint fixation*). In gouty and rheumatic subjects constitutional treatment is required.

Where much thickening results after a sprain, the joint as well as the muscles which act over it should be steadily treated by massage (Chap. xix.).

Bruises must be treated much in the same way as sprains—by restraining subcutaneous hæmorrhage at first, giving rest to the injured tissues, and afterwards promoting absorption. The domestic remedy of a piece of raw meat bandaged over a bruised part is an example of a good means of ensuring cold and pressure. Hence its value.

CHAPTER XVIII.

EXTEMPORARY APPLIANCES AND CIVIL AMBULANCE-WORK.

Contents.—Extemporary Appliances in Civil Life—Accidents—**Fractures**—Extemporary Splints—How to lift and carry an Injured Person—Extemporary Stretchers and Slings—**Bleeding Wounds**—Domestic Antiseptics available—Bleeding from an Artery—Extemporary Tourniquet—Rules for Bearers of the Wounded—Formation of Ambulance Classes.

In time of war, the necessities of the case demand that use should be made of whatever comes first to hand for the extemporary manufacture of splints and stretchers. As no amount of precautions and no organisation can ever entirely obviate the difficulties of attending to the Wounded in war, the utilisation of arms and accoutrements for making splints and stretchers, and the possible applications of a triangular handkerchief as a simple form of bandage and retentive apparatus, have been made the special study of military surgeons in civilised countries. In recent years it has been recognised that circumstances much resembling those of war very frequently occur in civil life—in so far, that accidents of all kinds happen when no trained assistance is at hand, or special apparatus is available. On this account, Civil Ambulance classes have been formed all over the country in order to train non-professional persons to give "first aid" to the injured with such apparatus as may be generally available. So much attention has been given to this subject by lay-people, that few medical men—far less medical students—could, without having specially studied it, put up an ordinary fracture on the street so neatly or so well with umbrellas, sticks, and handkerchiefs, or other extemporary apparatus, as a well-trained member of one of those classes. Considering that many of these men are skilled mechanics, and that they enter upon this practical work with the keenest interest, we need not be surprised that their standard of excellence is very high, It, therefore, becomes the profession to see that they are not outstripped in this matter by their lay brothers. We shall here briefly

indicate the chief points requiring attention; practice must do the rest.

Fractures—(A) Of the Lower Limb.—It is of great importance to decide at once whether or not a fracture is probably or possibly present, because fixation of the broken bone should be ensured before the injured person is lifted or disturbed.

The *Diagnosis* must be made chiefly from the helplessness of the limb, the pain, and the distortion, as it is not always advisable to test for crepitus, if it should not be manifest on the first gentle handling. In doubt, treat as if a fracture were present.

Fig. 122.—Extemporised Splint made from Twigs knotted together.

The great secret in handling a fractured limb is to keep up extension upon it, until the splints be applied.

(*a*) *Extemporary Splints*, it is needless to say, may be of any material that will give the necessary stiffness. For shorter splints, a mass of folded paper of any kind does very well, or a folded coat, sacking, or other stout cloth. Nothing is better than the straw envelopes used for packing bottles. Pieces of fire-wood, old wooden

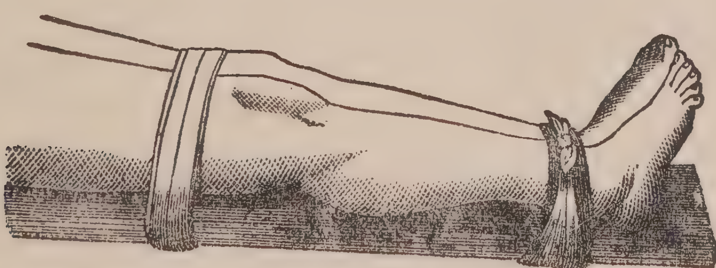


Fig. 123.—Steadying the Lower Limb.

or pasteboard boxes broken up, walking-sticks, and umbrellas, are also generally available.

A capital splint may be made by knotting together pieces of wood, wisps of hay or straw, or bundles of twigs. This is used in the army, and makes a splint which closely imitates Gooch's, adapting itself easily to the limb (Fig. 122). For binding the splint in position, handkerchiefs, cravats, twine, or rope, may be used.

It will be found an additional security (especially in fracture of the thigh, or where the patient has to be carried a long distance) to utilise the sound limb by fixing it to the injured one after the splints have been applied. Three bands are generally enough—one at the ankle, another at the knee, and the third round the thigh. In addition,

a board may be fastened below the legs, to make all secure (Fig. 123). A long splint may be extemporised from a broom-stick, or any other piece of wood or metal which is about the right length.

(*b*) *How to lift and carry the Patient.*—Supposing a fracture to have occurred on the street, and the injured limb to have been secured with temporary splints—the next matter is to lift the patient, and carry him to his house or the nearest hospital. A patient thus injured may be carried (1) in the arms; (2) on a blanket; (3) on an extemporised stretcher.

(1) *In the Arms.*—Three or (if available) four bearers are required to carry a patient in the horizontal position.

Getting into Position.—While the patient is still on the ground, the bearers range themselves on his sound side (say, his right), and stooping down, put the left knee (in every case) on the ground with the right foot near it. No. 1 is opposite the shoulder, and placing his left arm beneath the right shoulder, leans across and passes his right arm under the patient's left axilla, and tries to meet his hands beneath; the patient at the same time, if able, clasps No. 1 round the neck and shoulders. No. 2. also on the right side, passes *both* arms well below the patient's pelvis. No. 3, still on the same side, passes one arm below the thighs, and the other below the legs. If there be a No. 4, he goes to the opposite side, and helps to lift the trunk and thigh, by passing his arms below.

First Stage.—When all are ready, No. 4 (or whoever is taking the lead) gives the word to lift. The patient is then raised from the ground, and supported on the right knees of the bearers, which, from the position assumed, project as a convenient support.

Second Stage.—A stretcher, if available, should now be placed beneath the patient by No. 4, who then assists in lowering the patient into it. Should there be no stretcher, the bearers, having adjusted their hold in the first stage, can then more readily rise to the erect position in the second, and carry the injured person to a place of safety. As this is a fatiguing mode of carrying to all concerned, it should not be attempted for more than one or two hundred yards.

Where only two bearers are available, the patient must be carried in the sitting position, by the two-, three-, or four-handed seat. The four-handed seat is best when the patient can clasp his bearers round the neck; the two-handed seat is available when two bearers have to carry a nearly unconscious patient; and the use of the three-handed seat is for an intermediate condition.

Four-handed Seat (Fig. 124).—The bearers place themselves on each side of the wounded person, facing obliquely towards him, and stooping down. Each grasps his own left wrist with his right hand, and with his left hand grasps the right wrist of the other bearer. The patient places himself on the seat thus formed, and puts an arm round the shoulders of each bearer as they rise to the erect position.

Three-handed Seat.—The bearers having placed themselves in the same position relative to the patient, the one on the right (No. 1)

grasps his own left forearm with his right hand, and with his left hand he grasps the left forearm of the other bearer, No. 2, who at the same time uses his left hand to take hold of the right forearm of No. 1. The patient is placed on the seat thus formed, and steadying himself a swell as he can with his arms (as in the four-handed seat), he is still further supported by the free right hand of No. 2, placed behind him, and grasping the back of the coat of No. 1.

Two-handed Seat (Fig. 125).—The bearers having placed themselves as before, kneel on the knee which is to the front (right of No. 1, and left of No. 2), and placing their hands beneath the patient's arm-pits, raise him into a half-sitting posture against their other knees. They now pass their front arms beneath his thighs, and locking the fingers together with the palms uppermost, form a support for him. Their other hands are now made into a back-support, each grasping the other's wrist. Rising together, they lift the patient, and proceed to carry him off.

Fig. 124.—Four-handed Seat

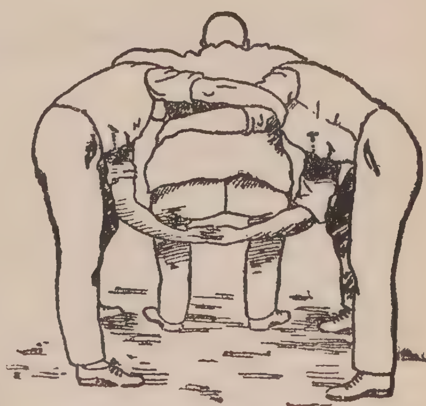


Fig. 125.—Two-handed Seat.

The great secret of all these seats is for the bearers to press strongly together, by so doing the ease of carrying is greatly increased.

(2) *On a Blanket, Rug or Strong Sheet.*—Two bearers on each side are required; the blanket having been spread out below the patient, its side edges are rolled on themselves, close up to his body. The contiguous hands of the bearers on each side grasp the rolled blanket about opposite the patient's loins, while with their other hands they seize it, opposite his shoulders and knees respectively. They can now easily lift him. If he be unable to support his own head another person must attend to this, or the blanket must be seized higher up. A stiff rod or pole, if rolled into the edge of the blanket, increases the facility of lifting.

(3) *On a Stretcher.*—Where a regular stretcher is not available, a substitute is easily made. If a shutter or a board is not to be had, a short ladder, wooden gate, or part of a fence, does very well. If two stout poles can be found, it will not be difficult to supply the necessary material to stretch between them. Ordinary ropes, or

those made from twisted hay or other material, may be laced across from side to side, or holes may be made in the ends of sacks and the poles pushed through. Or again, cloth, sacking, etc., may be nailed to the poles. Coats may be used by turning the sleeves inside out, and buttoning the front of the coat over the poles. Two or three ordinary coats are required for this purpose. If an ulster be available, it will be still better. If a transverse bar to keep the poles apart can be supplied, it will much facilitate the ease of carrying (Fig. 126).

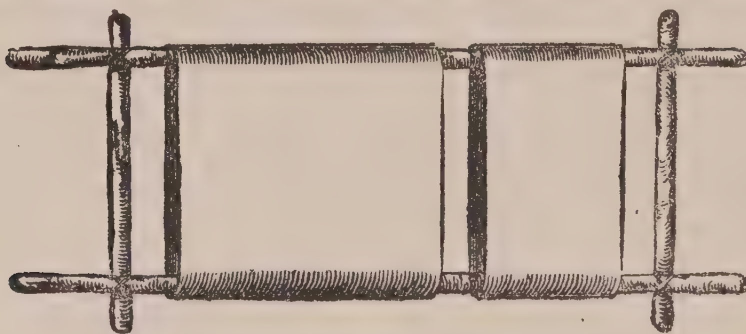


Fig. 126.—Stretcher made with Poles and Cloth

Should it not be possible to find suitable single poles, strong walking-sticks or umbrellas can be used—if tied together with handkerchiefs or rope. Two extra assistants, however, will then be required. The handled ends of the walking-sticks are to be placed together, and each firmly looped on to the end of a handkerchief. The coats or other material are then slipped over the sticks, the middle of the handkerchiefs being left out to be grasped (Fig. 127), while the ferruled

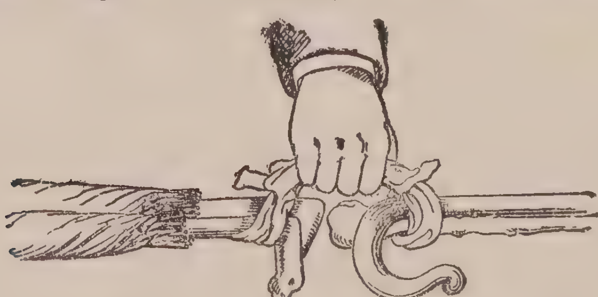


Fig. 127.—Mode of utilising Sticks, &c., as Stretcher Poles.

ends of the sticks project in front and behind to be grasped by the front and back bearers. No attempt is made to *splice* the sticks, and so assistants must lift their attached ends.

(B) Fractures of the Upper Limb—Fore-arm, or Upper Arm.—Any thick fold of cloth or paper, or a piece of wood or metal, will keep the bones steady until regular appliances can be obtained

A *sling* is very easily made from two ordinary pocket-handkerchiefs, by tying one loosely round the neck, and after laying the forearm

diagonally on the other, tying its two side corners within the first (Fig. 128).

Other slings may be made by folding up the side of a coat, and pinning or buttoning it in position, ripping up the seam of the sleeve, and folding it over the arm, or suspending the limb with a cravat or sash.

If the *clavicle* be broken, all that is needed is to support the elbow well by an extemporary sling, and bind the arm to the side. Should the handkerchief round the neck press upon the broken bone, the two ends of handkerchiefs must be knotted together. One handkerchief is then placed over the sound shoulder, while the other, spread out, and passing below the elbow of the injured side, is carried to the back to be fastened there to the free end of the first handkerchief.

A fractured *lower jaw* requires to be supported by pressure from below against the upper jaw. A handkerchief round the chin will be found sufficient.

(C) Bleeding Wounds.—In the extemporary treatment of bleeding wounds, whether with or without a fracture, there are three objects to be kept in view, viz.:—(1) Stopping the bleeding; (2) covering up the wound; (3) fixing the part to ensure rest.

Fig. 128.—Pocket Handkerchiefs used as Sling.

The first and second indications may often be combined by fixing a firm pad over the wound. As dry absorbent wool charged with an antiseptic is not likely to be available, any clean dry piece of cloth may be used instead. If an antiseptic be not at hand to cleanse the wound, should it be evidently dirty, boiled water will be at least a-septic, as will be any rags or cloths wrung out of boiling water; if applied hot to the wound, they will have, in addition, a hæmostatic effect, and should replace the dry rag. (*N.B.*—Although a recently washed and clean cloth is not necessarily aseptic, it will be more nearly so than one which has been collecting dust from all sides since it left the washing-tub.)

Domestic Antiseptics are:—Turpentine (also an excellent hæmostatic), and alcohol in the form of spirits, strong wines, or methylated spirits of wine; treacle or golden syrup, or a syrup of ordinary sugar; glycerine. Powdered charcoal, or sulphur, is also efficacious, and is often to be had.

In some country-places peat-turf is abundant. This has been largely used in Germany for wound-dressings. It should be crumbled fine, freed from lumps, and applied to the wound in bags of muslin, if possible.

Bleeding from an Artery.—When a large artery is wounded, and direct pressure upon it is not possible, the bleeding must be controlled

by digital compression (Fig. 129) by a tourniquet or by forced flexion. Forced flexion maintained by a bandage is most easily carried out at the elbow and knee. It may be aided by a pad in the

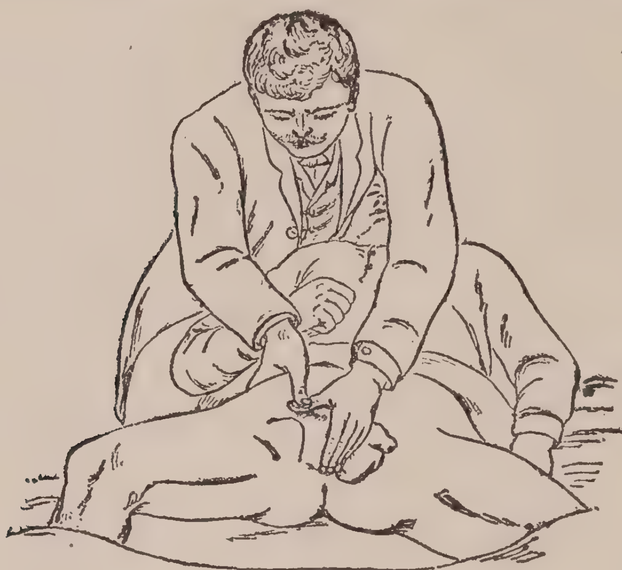


Fig. 129.—Digital Compression of Femoral Artery

flexure of the joint, but this is not essential. A simpleway of fastening the bandage, which is to keep up the forced flexion of the knee, is to pass it through two slits in the patient's boot just above the heel. The femoral artery may also be compressed by forcible flexion of the thigh on the trunk. While any one can stop the pulse at the wrist by voluntarily forcing his arm down behind his back, as Braune showed, it is practically impossible to control the circulation in another person by bandaging the limb in this position. In an emergency Keene's method (p. 59) would be indicated where digital compression could not be continued, as in carrying a patient in an ambulance. In the case of the thorax or abdomen, firm circular compression over the seat of an injury where internal hæmorrhage was suspected would be of two-fold service. It would ensure rest, and it would, in the abdomen especially, restrain hæmorrhage. An extemporary tourniquet may be made from any scarf or piece of rope, as

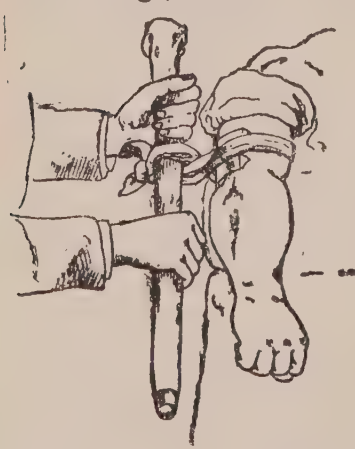


Fig. 130.—Extemporised Tourniquet.

follows (Fig. 130):—Knot the band round the limb so loosely that the fingers may easily pass beneath the band; take a piece of strong stick and twist it into the loose band: then take a piece of paper and lay it on the skin just below the stick, to prevent the skin being nipped in; now, twist the stick round until the band is sufficiently tight. If a handkerchief or scarf be used, a stone or other firm substance may be folded into it to form a pad over the main vessel of the limb. It should never be forgotten that the pressure of a tourniquet, though sometimes necessary, is always more or less injurious, and in five or six hours is likely to damage seriously the tissues below the point where it is applied.

(3) The third object, *fixation*, should be ensured in the limbs by applying an extemporary splint after the bleeding has been stopped and the wound occluded.

Rules for Bearers of the Wounded.—The rules given in military works for carrying wounded men on stretchers are:—

(1) To place the patient towards the injured side, in a wound of the chest or lower limb.

(2) Towards the sound side, if the upper limb be injured.

(3) On his back with legs drawn up, if the abdomen be wounded.

These indications may also be of service in carrying hospital patients to and from the operating theatre. The front bearer in carrying a stretcher should be *out of step* with the rear bearer, to prevent a disagreeable swing. It is better generally to carry the patient feet foremost; but in going on a hill, the patient's head should be towards the top, unless the injury be a fracture of the thigh, in which case the injured limb should be uppermost.

Formation of Ambulance Classes.

Practitioners in country districts are frequently asked to undertake a course of Ambulance Lectures, and from want of special training in ambulance work are often at a loss to know how to proceed. If they can arrange the matter with their pupils, practitioners in such a position should form a local branch of one or other of the existing Ambulance Associations—*e.g.*, of the St. John Ambulance Association in England, or of the St. Andrew's Ambulance Association in Scotland. If they put themselves in communication with the secretary of either Association, they will be furnished with full instructions "how to form a class," and will be able to get the loan of a Skeleton, a Stretcher, Diagrams, and the other necessary apparatus.

Should no such formal work be desired, the practitioner cannot do better than take as his basis the Syllabus laid down by one or other of these Associations, and make such modifications as the circumstances of his case may seem to indicate.

The following is the Syllabus of Ambulance Lectures as laid down by the St. Andrew's Ambulance Association:—

SYLLABUS OF AMBULANCE LECTURES.

First Lecture.—A. Introductory remarks, explaining clearly the scope and object of lay help in ambulance work, special attention being drawn to the need for it, as well as the usefulness and simplicity of it.

B. Short sketch of the general anatomy of the human body, including a brief description of the functions of digestion, absorption, circulation, respiration, excretion, secretion, and innervation.

C. Uses of a bandage—Of the two kinds of bandage, the roller not needed for ambulance work—Description of Esmarch's triangular bandage, pointing out (1) its advantages, (2) method of folding it and fastening it, (3) its application in different ways—Hints as to the "first dressing" of wounds by ambulance pupils.

Second Lecture.—A. Short account of the skeleton, with brief description of the structure and varieties of the joints

B. (1) *Fractures*—Their varieties, causes, symptoms, and dangers—Their temporary treatment and the apparatus necessary for it. (2) *Dislocations*—How they differ from fractures, and the first aid in such cases—No necessity for immediate reduction, and the dangers of attempted reduction by non-professional persons.

C. Illustrations of the temporary treatment of the following *simple* fractures—(1) collar bone, (2) upper arm, (3) forearm, (4) the hand, (5) thigh, (6) leg, (7) foot, (8) lower jaw.

Third Lecture.—To be devoted to practical work, when the members of the class will exercise themselves in the use of the triangular bandage and the temporary treatment of the different fractures mentioned in the previous lecture.

Fourth Lecture.—A. (1) General description of the circulation of the blood, and the mechanism by which it is carried on—(2) Distinction between arterial, venous, and capillary hæmorrhage—(3) Names of the main arteries of the body, with their situations—(4) Points where arterial circulation may be arrested by pressure—(5) Dangers of hæmorrhage.

B. General treatment of hæmorrhage:—I. *Internal hæmorrhage*—First aid in cases of (1) bleeding from the nose, (2) spitting of blood, (3) vomiting of blood. II. *External hæmorrhage*—(1) Application of cold, either by water or exposure to air—(2) Elevation of part—(3) Local pressure—(4) Distant pressure on main artery supplying wound, either by hand or tourniquet—(5) Three kinds of tourniquet: elastic, screw, and improvised.

C. Show mode of applying elastic or screw tourniquet, and of making an improvised one—Give illustrations of arrest of hæmorrhage from (1) scalp, (2) neck, (3) armpit, (4) upper arm, (5) forearm, (6) hand, (7) thigh, (8) ham, (9) leg, (10) foot—Give illustrations of temporary treatment of a *compound* fracture, with hæmorrhage in upper or lower extremity.

Fifth Lecture.—To be devoted to practical work, when the members of the class will exercise themselves in the arrest of hæmorrhage in various situations, and in the temporary treatment of *compound* fractures.

Sixth Lecture.—A. Short account of respiration, its objects and mechanism.

B Fainting, its causes, symptoms, and treatment—Immediate treatment of those apparently drowned, or suffocated by (1) hanging, (2) poisonous gases, (3) choking—First aid in cases of (1) burns and scalds, (2) bites by animals possibly rabid, (3) tears from machinery, (4) crushed and bruised parts, (5) stabs.

C. Show mode of performing artificial respiration (Sylvester's method), and also the temporary treatment of fractured ribs.

Seventh Lecture.—To be devoted to practical work, when the members will exercise themselves in performing artificial respiration, and in the arrest of hæmorrhage from supposed cases of ruptured varicose veins, stabs, tears from machinery, and gunshot wounds.

Eighth Lecture.—A. Short account of the nervous and digestive systems.

B. Symptoms and first treatment of shock or collapse.

C. First aid in cases of (1) those stunned by fall or injury to the head, (2) of convulsions, (3) of epilepsy, (4) of sunstroke, (5) of persons found insensible, (6) of suspected poisoning, (7) of frost-bite, (8) of lime in the eye, (9) of supposed death.

Ninth Lecture—for Males only.*—A. Removal of Injured by means of stretchers, special attention being directed to (1) the proper carriage of the stretcher, (2) the manner of placing it, (3) the loading and unloading it, (4) the position of the patient on it, (5) suggestions as to overcoming difficulties on the road, (6) hints as to the conveyance of stretchers by rail or country carts.

B. Short account of some of the improvised methods of removing injured persons when no stretchers or regular conveyances

* In Ladies' Class, Lectures on Sick Nursing will take the place of these Lectures.

are available, as by the two-handed, three-handed, and four-handed seats.

C. Give illustrations of how to prepare and fold up a stretcher.

Tenth Lecture—for Males only.*—Stretcher drill in presence of and under direction of Lecturer.

SYLLABUS OF LECTURES TO WOMEN ON HOME NURSING AND HYGIENE.

I. THE SICK-ROOM.—Introductory Remarks. The Sick-Room—its Selection, Preparation, Cleaning, Warming, Ventilation, and Furnishing—Bed and Bedding.

II. INFECTION AND DISINFECTION.—Infectious and Non-Infectious Cases—Quarantine of Patient—History of a Fever Case—Disinfecting and Disinfectants.

III. DETAILS OF NURSING.—The Nurse: Management of Nurse's own Health—Regulation of Visitors—Washing and Dressing Patients—Bed-making—Changing Sheets—Lifting Helpless Patients.

IV. DETAILS OF NURSING.—Sick Diet: Administration of Food, Medicines, and Stimulants—Observation of the Sick as to (1) Rigors, (2) Sleep, (3) Pain, (4) Posture, (5) Skin, (6) Appetite, (7) Vomiting, (8) Cough, (9) Expectoration, (10) the Effects of Remedies.

V. DETAILS OF NURSING.—The Pulse—Taking of Temperature—Baths—Bed-Sores—Delirium—Nursing Sick Children—What to prepare for the Physician's and Surgeon's visit.

VI. APPLICATION OF LOCAL REMEDIES.—Poultices—Fomentations—Blisters—Ointments—Leeches—Padding—Splints—Bandaging—Personal and Family Hygiene—Management of Convalescents.

Should more information be desired, consult The British Red Cross Society's Manuals, by James Cantlie, F.R.C.S., Messrs Cassell & Co., 1913 (Vol. I., *First Aid;* Vol. II., *Nursing;* Vol. III., *Training*).

* In Ladies' Class, Lectures on Sick Nursing will take the place of these Lectures.

CHAPTER XIX.

MASSAGE.

Contents.—Utility of Massage—Physiological effects produced by it—Objects aimed at in the use of Massage—Movements employed: (*a*) "**Stabile**" (Pressing, Hacking, Thrusting, Tapping, Pinching)—(*b*) "**Labile**" (Stroking, Kneading, Rubbing)—Time to be occupied at each Sitting—The *Effleurage-Pétrissage-Effleurage* sequence—Surgical conditions (including Fractures) in which Massage will be beneficial—Caution.

ALTHOUGH the term "massage" has been objected to, as now meaning more than merely "kneading," still it is a convenient word to express those manipulations of muscles, joints, and other parts, which are often so very useful as a means of treatment.

It seems right in a work of this sort to explain the methods employed, and indicate generally their applications to surgical disease, for there can be no doubt that "massage" is invaluable in certain cases, and no well-educated surgeon or physician should be ignorant of its general principles.

Many are deterred from studying the subject by the assertion that no one can learn it without special personal instruction. Schreiber, however, in his eminently scientific *Manual of Treatment by Massage*, says as to this, that "the necessary knowledge and skill can very well be mastered *without* an instructor, if, with each manipulation, the final end, namely, the physiological effect, be kept strictly in view."

Physiological Effects.—What, then, are these physiological effects?

1. Soothing and gentle stimulation of *cutaneous nerves* by stroking the skin.

2. Encouraging venous and lymphatic *circulation* by stroking towards the heart. The vessels reached will depend on the part and on the depth of pressure. Following from this, there results increased activity of the circulation of the part so treated—*i.e.*, dilated arteries and capillaries, and a more rapid current of blood, and, in consequence, increased warmth, more active nutrition, and the removal of effused material. Muscles after massage have their electrical conductivity as well as their voluntary motor power greatly increased, and they recover from exhaustion much more rapidly than when left to themselves.

3. Mechanical stimulation of the *tissues*, leading, probably, to molecular changes, and resulting in increased activity of circulation and of metabolism. The tissues most usually affected besides the blood-vessels are the muscles, nerves, and in pathological conditions

inflammatory exudations. There is no reason why gland-tissues might not be affected in a similar way.

Objects aimed at in Massage.—These effects of massage are applied—

(1) To stimulate the circulation locally or generally; increase metabolism, and encourage nutrition, whether in the skin, in glandular organs such as those of digestion, in special groups of muscles, or in the body as a whole. Also to equalise the circulation, and draw blood away from congested areas (*e.g.*, shampooing to induce sleep).

Eccles* points out that light friction of the skin increases the pulse rate, probably through the agency of the nervous system; while deep muscular shampooing generally slows the pulse, probably by dilating the vessels in the muscles.

Fig. 131.—Pressure—Rapid Lateral Movements.

Fig. 132.—" Hacking."

By exciting molecular changes to remove certain neuralgias—*e.g.*, some forms of sciatica, and myalgias of the recent rheumatic or lumbago type.

Although an almost endless number of methods of manipulation has been advocated, the chief of them only need be described here.

The Movements employed.—The simplest subdivision of the movements is that adopted by Schreiber, who classifies them as " stabile " and " labile." Under the first he includes pressing, tapping (or beating), hacking, pinching, and concussing; under the second, stroking, rubbing, and kneading.

(*a*) **Stabile Movements.**—(1) " Pressing " may be done with the tip of one or more fingers, with their phalanges (especially 2nd), or with the knuckles. The simple pressure may be modified by lateral or rotatory movements, or by passing into a rubbing or kneading movement. The amount of pressure employed will vary with the depth to be reached, and the object to be attained (Fig. 131).

* *The Practice of Massage.*

(2) "Tapping, thrusting, hacking" (*i.e.*, "*Tapotement*") indicate sudden effects produced more or less forcibly. "Tapping" is done with the pulp of the fingers from the wrist, as in percussing the chest, or by knocking, as at the door, with the knuckles. "Thrusting" is poking up the deeper parts with the tips of the extended fingers, knuckles, or closed fist. "Hacking" is striking the muscles with the ulnar edge of the open hand or fingers, according as more or less force is required. It is used in dealing with the larger groups of muscles, and with deep nerves (Fig. 132).

Under this head may also be included "shakings" of various parts, and "vibrations," or more rapid and finer "shakings." Both are methods of producing mechanical stimulation.

(3) "Pinching" is a grasping of the soft parts, either with the tips of the thumb and fingers, or with the pulp of the same, applied specially to muscles and groups of muscles. A series of pinches following one another along the muscles in a centripetal direction is said to force onwards the venous blood and lymph. This may result to a certain extent. Those who insist most, however, on the necessity for anatomical knowledge in the masseur, seem to forget that to a certain extent in all muscles, and very markedly so in some, the blood-vessels enter the muscles at certain central points from which they afterwards radiate. We would, therefore, believe that the chief value of this manipulation is the mechanical disturbance produced.

Figs. 133 and 134.—"Pinching."

A modification of pinching consists in "squeezing" the tissues between the ball of the thumb and the tips of the fingers, after the fashion of what schoolboys term a "Horse bite"—one of their numerous forms of mild torture.

(*b*) Labile Movements comprise stroking, rubbing, and kneading.

(1) Centripetal stroking or "milking," when applied to the veins and lymphatics, is known as "*effleurage*." This increases the circulation, and aids absorption. It precedes and follows most other movements to clear out the main trunks and prepare for their being filled. and afterwards to sweep away accumulations within them.* It is carried out either with the flat of the hand or with the edges of the spread-out forefinger and thumb, followed up with the palm of the

* **Grant, *Edin. Med. Journal*, Aug. 1887.**

hand. Muscles and groups of muscles are to be so treated as well as the subcutaneous textures.

(2) Friction, "kneading" (*Pétrissage*), or rubbing proper, consists in firm pressure moved over special spots. It is specially applicable to inflammatory thickenings, in and round joints and tendon sheaths, and in the substance of muscle. It may be done with the finger-tips or knuckles: but the pulp of the thumb will be found specially useful. The operator tries to dispel the thickening, as if by his own efforts, although he knows that probably the chief benefit will result from the after-vital changes which he sets up.

Applications to the Patient's Skin to facilitate Rubbing.—A fine dry powder is the most commonly used medium, such as powdered talc, boracic acid, or starch, singly or combined; violet toilet powder is very good, ordinary flour does well in an emergency. Should the rubber's hands be rough an oily substance is advisable, such as olive or neat's foot oil.

Time Necessary.—The time to be occupied at each sitting is a matter of opinion. Dr. Grant, writing after a visit to von Mosengeil's Clinique, believed that in Britain the period is generally too much prolonged. His view was "That when once the muscles have been fairly and completely emptied of venous blood, lymph, and waste products, and when once an active afflux of arterial blood has been established, nothing more can be done for the time." In general massage, "every muscle should be subjected to *two successive processes of effleurage-pétrissage-effleurage*," and this should be done by rapid movements in from ten to fifteen minutes. In local massage, about the same time may be occupied, except where inflammatory thickenings have to be got rid of, when a somewhat longer time may be taken. Once a day is generally sufficient.

The Commoner Surgical Conditions in which Massage is applicable are:—

(1) *Stiff Joints*, resulting from prolonged fixation for any reason, or following simple inflammation in and around the joint.

(CAUTION.—*The stiffness following tuberculous anthritis is generally in old, and always in recent cases, best left alone, lest the original mischief should be re-excited.*)

In these cases, the massage is applied to get rid of inflammatory thickenings, and to stimulate the growth and activity of muscles, which have been atrophied from disuse. Greater benefit results if, before the massage, the joint or limb is subjected to a local bath of hot air or vapour, or to a stream of hot dry sand repeatedly applied. Failing these, hot water may be employed. Progressively increased passive and active movements, and faradisation, are also useful.

(2) *Inflammatory Thickenings* in any accessible parts—*e.g.*, round urethral strictures, in callous ulcers, in the testis after orchitis (non-tuberculous), after neglected injuries to joints, etc.

(3) *Rheumatic Contractions and Thickenings*, where similar applications are made upon the affected muscles and the skin over them.

(4) *Recent Effusions,* to promote absorption of blood and serum by effleurage. In this lies the great value of massage in sprains and after reduction of dislocation. The effleurage is cautiously applied at first only to the limb on the proximal side of the injury. By the emptying of the veins and lymphatics they more rapidly absorb the effusions from the sprained part and so relieve tension, and permit of early movement. As the tenderness subsides the nutrition of the muscles can also be maintained by a deeper massage which reaches their substance, and before long the massage can be applied directly to the injured area. The time at which these stages in the process will be carried out will vary with the severity of the injury and the skill and judgment of the masseur. Some also advise the promotion of absorption of other forms of synovial distention in the same way.

(5) *In Fractures.*—In recent cases massage is valuable from the first, and is much more effective in preventing adhesions than in curing them.

According to Professor Lucas Championière's directions, the patient is to be placed in the most comfortable position possible, and the injured limb laid on a pillow, and if need be steadied by an assistant or the surgeon's disengaged hand. A hypodermic injection of morphia should have been given if there has been much pain, especially if due to muscular spasm.

The operator begins with gentle effleurage (p. 209) on the proximal side of the injury to empty the veins and lymphatics. Using as broad a surface of the hand and fingers as possible he is guided by the principle of *not causing pain,* and "strokes the limb as he would a cat"; at the early séances, he can seldom touch the seat of injury without causing pain, but he should stroke the parts distal to it. Where even the lightest stroking causes pain, a series of "caressing touches" from below upwards may be employed.

Attention is next directed to the *muscles*—singly or in groups—which pass over the fracture or which act upon the fragments. According to the degree of tenderness, the massage of the muscles will vary as before, from a series of caress-like touches to more firm pressures, or even very gentle kneading. The muscular substance will be followed from below upwards. The séance is closed with the effleurage or caress-like touches with which it began. Time, ten to twenty minutes.

In some cases the séance is a daily one, in others at intervals of one to three days, splints—if in use—being temporarily removed.

As symptoms become less acute (about fourth or fifth day) the pressure used becomes firmer and the movements more extensive. Definite collections of blood or serum are dealt with by a kneading or circular milling movements of the masseur's hand or finger tips. As at first the muscles are stimulated by pressure and kneading movements, and the séance closed with effleurage.

When the fracture involves or is near a joint, massage should not be applied to the broken ends of the bone for fear of unduly increasing

the callus or disseminating osteoblasts. There is no risk of non-union of cancellous bone fragments when in apposition to one another. Every other structure has to be treated by massage—the ligaments, synovial membrane, tendon sheaths, and the muscles acting on the bones which form the joint.

CHAPTER XX.

SURGICAL APPLICATIONS OF ELECTRICITY.

Contents.—Various Forms of Electricity Employed—Mode of Producing the Electrical Current—The "Galvanic," and the "Faradic" Current—Electro-Diagnosis—Electro-Therapeutics—Caution—Selection of Current—Duration of the Application—Motor Points—Mode of Application—Electrolysis—The Galvano-Cautery.

COMPARED with its uses in Medical practice, the applications of Electricity to Surgery are less extensive, besides being chiefly of a different kind. For full information on "Medical Electricity," we must refer our readers to some of the special works on the subject. In the present chapter we shall only attempt a brief explanation of some of the more important applications of Electricity to Surgical practice.

The Forms of Electricity employed are the **Galvanic**, or Chemical current, allowed to remain continuous, more or less slowly interrupted, or occasionally reversed, and the rapidly interrupted induced **Faradic** current. The terms "Galvanic" and "Faradic" are derived from the name of the discoverer of the special form of current in each case. Electricity is the same thing under all circumstances, but it differs in its effects according to the way in which it is produced.

Before we speak, however, of the applications of current electricity, we must understand the mode in which it is produced.

Mode of Producing the Electrical Current.—The Galvanic Current is obtained from some form or other of "cell" or "element." This depends for its construction on the fact that when two dissimilar metals, or a metal and carbon, are immersed in a corrosive fluid, and either touch at one point or are united by a connecting-wire, an electrical current is established in the "Circuit," which is the term used to express the combination of metals, fluid, and connection. One such arrangement is called a *galvanic cell* or *galvanic element*, while a number of cells coupled together form a *battery* or *pile*.

The metal more easily attacked by the fluid is corroded, while bubbles of hydrogen gas form on the other. The current is said to begin at the corroding metal, pass through the fluid to the other metal

or carbon, thence through the latter, and back to the first metal by the point of junction or by the connecting-wire. The outer portion of the current—*i.e.*, that which flows along the connecting-wire, is that which is used for medical and other purposes. The points of attachment of the connecting-wire to the metals are known as the *Poles* of the cell. That Pole *towards* which the current flows in the outer part of the circuit is called the negative (—) pole, while the other *from* which it comes is called the positive (+) pole. Metals have been arranged in order according to the ease with which they are attacked. Thus, in dilute sulphuric acid, the order would be amalgamated zinc, ordinary zinc, iron, tin, lead, copper, silver, platinum, and carbon. The further apart the metals are in the series, the greater the difference in their "potential"—*i.e.*, the greater the tendency for a current to flow from the one to the other in a "cell."

Electro-Motive Force is the magnitude of the cause which produces the electric flow. It will, of course, vary with the metals chosen, and with the fluid in which they are immersed. Amalgamated zinc is generally chosen for the negative pole metal or *negative* plate; copper, silver pure or platinised, or carbon, for the other or *positive* plate.

As the cell works, a layer of hydrogen gas tends to gather on the positive plate, a process which is called *polarisation*, and which is important because its effect is to interfere with the original current by sending one in the reverse direction. Polarisation is a frequent cause of disorder in batteries. To obviate it (1) the positive plate is made rough, so that the hydrogen may form air-bells and escape by rising to the surface. (2) Some substance which absorbs hydrogen by uniting with it is interposed between the two plates—*e.g.*, dioxide of manganese in the Leclanché cell, dichromate of potash in the Grenet cell, sulphate of copper in the Daniell cell, etc.

The electro-motive force is always the same for the combination of any two metals immersed in a given fluid to form a cell, however large or however small the surface of metal exposed to that fluid be. It has been likened to the "head" of water, which is always the same for a given height to which a quantity of water may be raised, however any other conditions as to size of pipe, etc., may vary. The electro-motive forces of a number of cells can be superposed by coupling the cells together *in series*—*i.e.*, connecting the positive plate of one cell to the negative of the next, and so on; thus multiplying the electro-motive force by the number of cells employed.

The flow of Electricity is always more or less resisted, both within the cell (*internal resistance*), and there especially in the corroding fluid, which acts as a conductor; and also outside the cell (*external resistance*), in the wire or other conductor, which unites the two poles. The resistance, like that of a pipe to the flow of water through it, is in inverse proportion to the cross-section of the conductor, and in direct proportion to its length. Thus, the smaller the cross-section of the conductor, and the longer it is, the greater will be the

resistance which it offers to a current of electricity, and *vice versâ*. Hence, the larger the "plates" of a cell, the greater the cross-section of the fluid conductor between them, and so the less the "internal" resistance of a cell—a factor which can be still further diminished by bringing the "plates" nearer together. When the cells of a battery are united, not "in series," but "*in parallel*"—*i.e.*, with all the positive poles, and all the negative poles joined to one another, the electro-motive force remains as that of a single cell, but the internal resistance is diminished just as if the plates of a single cell had been enlarged as many times as there are cells in the battery. in such a case, any one of the coupled-together positive poles, and any one of the coupled-together negative poles will serve as the positive and negative poles of the battery. When desired, the cells may be united "in parallel" into groups of so many cells, the electro-motive force will then be multiplied by the number of groups, while the internal resistance will be diminished in proportion to the number of cells in each group. Thus, a battery of 30 cells may either be arranged entirely "in series," entirely "in parallel," or into groups, say into two groups of fifteen cells each, into three groups of 10 each, and so on.

The current strength (c) of a cell or battery, according to Ohm's law, varies directly with the total electro-motive force (E), and inversely with the total resistance [internal (ir), and external (er)], and is usually expressed thus—

$$c = \frac{E}{er + ir}.$$

When the electro-motive force is multiplied, say, 10 times, by coupling together 10 cells in series, the internal resistance, which belongs to each cell, is also multiplied to the same extent; but when the external resistance to be encountered by the current is very much greater than the internal resistance of the cell, this increased internal resistance may be neglected in comparison to the gain in electro-motive force attained by multiplying the cells in series. Hence, in passing currents of electricity through the human body, where the "external" resistance is enormous, the cells of a battery must be multiplied in number and arranged in series. On the other hand, when external resistance is comparatively slight, as in electrolysis of aneurisms, or of vascular tumours, or in the galvano-cautery wire, advantage is gained by diminishing the internal resistance; and this, as we have seen, is to be attained by increasing the size of the plates of the cells, or arranging the cells of a battery into groups, where like poles are united. Hence, for ordinary surgical electrolysis operations, or galvano-cautery work, as well as for the incandescent lamp of the cystoscope, a few large cells, or a few large groups of small cells, are what are needed. For electrolysis of uterine fibroid tumours by Apostoli's method, great electro-motive force, and consequently a large number of cells, in series, are needed.

In order to compare the strength of the various currents, certain

standards have been agreed upon by electricians. These are expressed as Volts, Ohms, Ampères, and Milliampères.

A **Volt** is the unit of electro-motive force. The electro-motive force of a single Daniell's cell is about 1 volt.

An **Ohm** is the unit of resistance to electric currents. It is the resistance of a column of mercury about 1 metre long and 1 square millimetre in section.

An **Ampère**, the unit of current, is that which 1 volt produces in a conductor of 1 ohm resistance.

A **Milliampère** is the thousandth part of an ampère. Milliampères are the standards usually referred to, when currents for medical or surgical purposes are spoken of.

A **Galvanometer** is an instrument used to measure the current which flows in any circuit. By its means, we are enabled to distinguish between the theoretical power of a battery and the actual current which at any given moment it is able to send through a conductor in the face of resistance. Its construction depends upon the fact, that a finely poised magnetic needle, if surrounded by a coil of wire, is deflected from its position, pointing north, when an electric current flows through the coil of wire. The stronger the current, the greater the deflection. By careful experiment, the degrees of deflection can be marked as equivalent to so many milliampères. Except for the electrolysis of superficial tumours (as afterwards explained), this instrument should be interposed in the circuit whenever the continuous current is applied for any purpose to the human body, as by its use alone is any approximation possible to the dosage of electricity employed. A perfectly accurate measurement of the amount of electricity which passes through the tissues does not seem attainable, owing to polarisation within the body and other sources of loss, which cannot be correctly estimated. With a galvanometer, however, we get the best possible approximation.

Electrodes are the terminals, connected with each pole of the cell or battery, which are applied to the body. They may be in the form of tubes holding a piece of sponge, or of variously shaped and sized pieces of carbon, covered with wash-leather. The larger the electrode, the more diffused the current which it transmits, and *vicè versâ*. Since the epidermis, when *dry*, is an extremely bad conductor, electrodes applied to the skin must be thoroughly moistened with water, plain, acidulated, or with a small quantity of common salt dissolved in it. For ordinary electrolysis, the electrodes should be in the form of needles insulated with vulcanite to within half-an-inch of their points.

Rheophores are the two connecting-wires between the poles of the battery and the electrodes. They are generally made of copper wire, and are insulated with gutta-percha or with silk. Sometimes they are differently coloured, so that a glance may tell to which pole they belong.

A **Rheostat** is an instrument employed to resist a current of electricity in a given and known way. Rheostats are made so that

a known number of ohms resistance may be interposed in a circuit. They are used as a means of gradually altering a current, since it will become either stronger or weaker as less or more resistance is interposed. A steadier current also is obtained from a number of cells strongly resisted, than from a few cells with little or no resistance.

Induced or Faradic Current.—This depends upon certain physical laws by which (1) when a current of electricity from a cell or battery flowing along a coil of wire is suddenly interrupted, an instantaneous reverse current is at once "induced," and runs through the wire in the opposite direction to the first. (2) When a second coil of wire is placed outside the first, and when in the latter a current is alternately allowed to flow and is interrupted, sudden currents are "induced" and run through the second coil in the reverse direction to those in the first or inner coil. The intensity of the induced currents in the second coil increases with the number of turns of wire which this coil contains and with its proximity to the first coil. In the faradic apparatus a special mechanism is provided for automatically and rapidly making and breaking the first current. By adjusting the rheophores the induced current from the first, or both currents from the second coil, may be passed through the electrodes. When the rheophores are attached to the first coil, only the induced current passes through them—for reasons that we need not stop to discuss. The current thus utilised is therefore rapidly interrupted in one direction. When, however, the rheophores are connected with the outer or second coil, both currents—*i.e.*, those in opposite directions—are passed through the electrodes. For this reason (and also because these currents are generally intensified by numerous turns in the second coil) the physiological effects produced by the currents from it are greater than those produced by the first coil.

A *Magneto-faradic* machine is sometimes used instead of the faradic current. The construction of this apparatus depends on the fact (1) that alterations in a magnet are produced by a bar of soft iron being brought near and then removed away from it, while at the same time the iron bar is itself magnetised and demagnetised in the process. And (2) that if the poles of the magnet and the iron bar are each surrounded by a coil of wire, each of the above changes is accompanied by the development of an induced current of electricity in the surrounding coils. By turning a handle in one of these machines, two iron bars are made to revolve rapidly past the poles of a fixed magnet, and, by special arrangement of coils of wire, the currents thus induced in them can be led in to the rheophores to which electrodes are attached. The apparatus requires no galvanic cell, but needs someone to turn the handle, and for this reason, as well as because the shocks are found to be rougher, it is less used than the faradic apparatus. It is, however, not liable to go out of order, and may be used in hospitals where assistants are generally easily procured.

Electro-Diagnosis is based upon variations which, in certain diseases of the nervous or muscular system, occur in the kind and

extent of response of muscles to stimulus, applied by electricity either to the nerve alone or to the nerve and muscle together. As the subject mainly belongs to medical cases, we shall not do more than thus merely mention it in passing.

Electro - Therapeutics. — In many cases of partial muscular paralysis, such as that from infantile paralysis, nerve lesion, or which follows long disuse from rheumatism, joint disease, or fracture, the application of Electricity may with advantage be combined with Massage (Chap. xix.) and hot and cold douching.

Caution !—When any lesion of the brain or spinal cord has caused the paralysis, no electrical treatment should be employed until all central inflammation has subsided, because it has been found that peripheral stimuli to the nerves are transmitted in a greater or less degree to the centre, and so are apt to aggravate existing inflammation there.

Selection of the form of Current suitable for each particular case is, of course, greatly a matter of experience, but the general indication available to beginners has been simply and briefly stated by Wood (*Therapeutics*), thus :—" *Always select that current which produces the greatest number of contractions with the least amount of pain.*" In order to do this, we are then told to begin with " the rapidly interrupted faradic, or the rapidly interrupted chemical current, and always when these fail to elicit response the slowly reversed chemical current, which, if necessary, may be increased in strength until the patient can no longer bear the pain." The rapid interruptions are made automatically by the interrupting apparatus, the slow interruptions and the reversal of the chemical current must be made by the operator's hand working the special mechanism provided for the purpose in the batteries as now sent out for medical purposes. Experience has shown that during the continuous passage of a current of electricity of moderate strength through a motor nerve, or through a nerve and muscle, no appreciable effect is produced ; but that when the current is suddenly interrupted, or suddenly allowed to pass again, a sudden contraction of the muscle takes place. This explains why a rapidly interrupted current produces more contraction of muscle than the same current flowing continuously. Further, it has been found that a " descending " current—*i.e.*, where the negative pole is applied nearer to the periphery than the positive pole—produces a greater effect than an " ascending " current, when the circuit is completed or closed—*i.e.*, when the current begins to flow ; but that, on the other hand, an ascending current produces a greater effect than a " descending " current, when the current is suddenly interrupted. Also, it has been found that an alternately reversed current produces a greater effect than a current (even though interrupted) which flows always in the same direction. Hence the rules given above. Although it is probably not the actual contraction produced which is beneficial to an impaired muscle, still it has been found in practice that the currents which elicit contractions, as above stated, are those from which the greatest benefit is obtained—

while strong stimuli, which have ceased to elicit contractions, should be given up, as they have been found to do more harm than good. In many cases, the first signs of returning motility are slight voluntary contractions, even when electrical stimuli are powerless to produce any.

Duration of Application.—This will depend on the number of muscles to be stimulated, and on their condition. The weaker they are, the shorter time they should be treated with electricity. Fatigue of the muscle is always deleterious, and should be avoided. It is usual to stimulate for a few seconds each muscle of an affected group in succession. No one muscle should have more than five minutes in all at the outside, and generally less. The sitting, which should only last for from ten to twenty minutes, may be repeated daily, or once or twice a week, according to circumstances.

Motor Points.—Duchenne, followed by Erb and others, has shown that on the skin over all superficial muscles there exists a special spot which yields the maximum of contraction, when an electrode conveying a given current is applied to it. These spots are called the "*motor points*" of those muscles, which respond to the stimulus thus applied. They should always be utilised in the application of electricity to muscles.*

Mode of Application.—For the *galvanic* current, one electrode, of large size, and for preference the anode (positive), should be placed against the patient's sternum or back, whilst the other electrode is pressed against the part to be stimulated. The size of the latter electrode will vary according to the concentration of the stimulus required: thus, a single fine nerve, on the motor point of a small muscle, will require a small electrode firmly pressed down, and larger areas will need larger electrodes, but somewhat stronger currents.

For the *faradic* current, one electrode (either will do) is usually placed over the main nerve supplying the muscle, while the other is applied over its motor point.

Electrolysis is the term applied to the decomposition of water, or other fluid or soft solid medium, by the passage through it of a strong current of electricity. The medium decomposed is known as the *electrolyte*, and when this happens to be water, hydrogen gas is found to gather round the negative pole, and oxygen round the positive pole. When the electrolyte is an organic fluid, such as blood, small quantities of strong alkali are found round the negative pole, and small quantities of strong acid round the positive pole. These minute quantities of acids and alkalies produce their characteristic effects upon the tissues, but have never been found carried into the general circulation.

It is to this their local action, especially that of the negative pole, that J. Duncan attributed the benefit of electrolysis for vascular tumours and goitre.

* Although their relative position will vary slightly in different individuals, still with a few trials they will soon be found at or near certain spots. These are indicated in the following diagrams in Landois and Stirling's *Text-Book of Human Physiology*, 4th Edition, viz.:—Figs. 505, 506, 507, 508, and 521, which see.

The cases in ordinary practice, for which (according to J. Duncan) electrolysis is best suited, are—subcutaneous nævi on exposed parts of the body, where therefore a scar is undesirable, cirsoid aneurisms, and intra-thoracic sacculated aneurisms not amenable to other treatment. The same authority also obtained good results in many cases of goitre.

The methods employed are similar in the above cases.

The battery should consist of from three to six large cells. A storage battery, if available, is the most convenient, but Bunsen's or Grenet cells are equally efficient. In many hospitals the current for lighting the town is employed, the strength of the current being reduced by a suitable form of rheostat. Duncan generally used from 40 to 80 milliampères of current, but since he advised the operator to be guided by the touch as the process proceeds rather than by the amount of current passing, he did not consider the galvanometer of any use except perhaps for sacculated aneurisms, where palpation is more difficult.

The needles should be insulated with vulcanite to within a short distance of their point, depending on the size of the nævus, and both should be thrust into the tumour or aneurism. Although the positive-pole needle, if made of steel, will be attacked by the acids which it sets free, the resulting salts are non-poisonous, and the needle can be easily re-sharpened. However, gold or platinum can be used for the positive needle, if so desired.

Mode of Procedure, say for a nævus, cirsoid aneurism, or goitre. The patient, especially if a child, is to be anæsthetised. The skin over and around the nævus is first cleansed and purified. The needles, unattached to the battery as yet, are then thrust through the skin an inch or two from the nævus, and are pushed subcutaneously into its substance, so that at the first sitting the deeper parts are chiefly attacked. As soon as the needles are placed in position they are connected with the battery, and the process begins. Soon a soft coagulum and crepitation from bubbles of hydrogen gas are perceptible round the negative-pole needle, while a firm hard coagulum is felt to form more slowly round the positive-pole needle. The latter is allowed to remain for the most part in one place, while the negative needle is moved from place to place as the desired effect is produced in each. During these subcutaneous alterations in position, the non-insulated part of the needle must not be allowed to reach the aperture in the skin. An entire coagulation to about the size of a walnut is sufficient for any single sitting. Care should be taken to prevent the cauterising effect from penetrating the skin to the surface. From twenty to thirty minutes is sufficient for one sitting. To obviate bleeding from the needle-punctures, the current should be maintained while they are being slowly withdrawn, so that a coagulum may block their track. Either needle, as soon as its non-insulated part reaches the skin, should be entirely withdrawn, and its aperture at once covered with collodion and wool. The other needle having been withdrawn and its aperture similarly dealt with, the whole of

the surface of the part electrolysed should be covered with wool and collodion, and be left alone for a fortnight or three weeks.

For the *Galvano-Cautery platinum wire point or loop*, a battery like that for electrolysis is required. Platinum is selected because it can be heated and cooled again any number of times without becoming oxidised, and because its fusing-point is so high. A current too strong to pass easily is sent through the wire, and heats it in proportion to the resistance which the wire, in virtue of small cross-section, offers. With either loop or point, a non-conducting handle is supplied, provided with a trigger which can be pressed with the forefinger so as to turn on or off the current.

For lighting the interior of the bladder or urethra, with the endoscope or urethroscope, small incandescent lamps with metallic filaments are employed.

Where the town-lighting current is available, a rheostat can be employed to reduce the voltage to the necessary degree.

Some form of storage battery is very convenient, but it must be re-charged once a month whether it has been used or not. A 6-cell bichromate fluid battery serves the purpose well. The cells have to be charged with the fluid before use, and to be washed free of the fluid after use. This takes a little time and trouble, but otherwise the battery is available at any time, however long the intervals between which it is used.

Again, a battery formed of dry Leclanché cells will remain useful for about eighteen months without attention. When the cells run down new ones can be bought for about 2s. 6d. each, and placed by the surgeon himself in the battery.

CHAPTER XXI.

JOINT-FIXATION AND FIXED APPARATUS.

Contents.—Remedial Effects of Absolute Rest—Local Sources of Irritation obviated by Rest—General principles of Treatment by Fixation, Extension, and Venous Congestion—Treatment of Cold or Tubercular Abscess—(A) **Treatment of Special Joints**:—(1) The Hip-joint—(2) Knee-joint—(3) Ankle- and Tarsal-joints—(4) Shoulder—(5) Elbow-joint.

Remedial Effects of Absolute Rest.—In certain chronic diseases of the joints—of the type known as strumous or tuberculous—the appropriate treatment in the early stage seems chiefly to be prolonged rest. The tubercle bacillus, which causes these chronic inflammations, may often be destroyed by the tissues under the conditions of improvement of the patient's general health, and rest to the affected part, aided by counter irritation, by venous congestion of the part

(Bier's method), and by the local injection of iodoform.* The rest, to be efficient, must be complete and prolonged for weeks, months, or even years—so long, in fact, as signs of disease continue, and for weeks after they have disappeared. Although in most of our General Hospitals, patients suffering from these chronic joint diseases may not be retained during the whole period necessary for their treatment, still the time allowed is often sufficient for improvement to begin, after the careful application of the immobilising apparatus which is necessary to complete the cure at home.

Local Sources of Irritation obviated by Rest.—The local sources of irritation to an inflamed joint which are obviated by ensuring its perfect rest, are :—

(1) *Voluntary Movements.*—These cause friction of the synovial and cartilaginous surfaces within, and of the fascia and tendons around the joint, besides compression of the joint-surfaces by the necessary muscular action.

(2) *Muscular Spasm.*—This indeed limits movement, and fixes the joint in the position of greatest ease; but continuous muscular action is involved, which helps to cause rapid muscular wasting, and continuous compression of joint-surfaces.

(3) *Transmission of Body-Weight* (in spine and lower limb), which, besides involving compression of articular surfaces and of bones, necessitates, reflexly, some action of surrounding muscles, however rigidly the joint may seem to be steadied.

Joint rest is obtained by (*a*) *Absolute fixation*, which not only obviates the first, but also the second source of irritation, for when a joint is steadied in its position of greatest ease without the muscles, they, being no longer needed, relax. As a result, joint-compression is relieved, the inflammation subsides, and a return to the natural position of the joint is soon possible.

(*b*) *Extension.*—This is specially called for in acute and subacute cases, and to be efficient the extension must *not* tend to directly undo any deformity that may exist (*Marsh*). This caution is especially necessary where there is acute distention of the synovial membrane, or where there is disease of the bone or articular surface.

To prevent the evils attendant on bearing weight, the patient must either be kept in bed, or be supplied with an immobilising apparatus, which takes the body-weight off the affected joint. The latter method is preferable in the less advanced chronic cases, since it allows the patient to enjoy some open-air exercise; the former is necessary in acute or in severe chronic cases.

In subacute and chronic tuberculous hip cases Thomas latterly reduced the deformity rapidly by bandaging the limb into his hip-splint, kept straight, and by tightening the bandage as soon as it became slack. Robert Jones, who continues the practice and methods of the late Mr. Thomas, holds that " the lumbar spine readily curves

* For a full discussion of the subject of Iodoform injection, see "Translation of Henle's Account of Mickulicz's Conservative Treatment of Tubercular Joints." Published by E. & S. Livingstone, Edinburgh.

when there is flexion at the hip sufficiently to allow the limb to be brought down to the splint when there is as much deformity as fifty degrees; but if the deformity be very great, as much, perhaps, as ninety degrees, it may be necessary to bend the splint just enough to get the limb in contact with it when the fullest possible lordosis has been obtained." It is probable that the cases which permit of this direct reduction of deformity will be chiefly chronic and sub-acute affections of the synovial membrane.

It is well to note that when a joint has to be kept absolutely quiet, other joints must also be fixed whose muscles either pass over the affected one, or are in co-ordination with its movements. Thus, in bad cases, the knee should be fixed with the hip, the ankle with the knee, and the elbow and the hand with the shoulder.

Bier's Method.—*Passive venous congestion* has been introduced by Bier of Berlin for the treatment of tuberculous joints and testicle. It is based on the rarity with which lungs, congested because of chronic heart disease, are attacked by tubercle. For all joints below the hip and shoulder the method is as follows:—Above the joint a piece of elastic webbing bandage is wound round the limb, sufficiently tight to produce a distinct bluish-red discoloration of the parts below. If Martin's solid rubber bandage is used, the skin is protected by a few turns of ordinary bandage or of lint. The congestion should be kept up for one or two hours out of the twenty-four for several months. It is well to restrict the degree of congestion to that which can be comfortably borne. The position of the constricting bandage should be altered from day to day. A watch must be maintained to recognise early foci of suppuration, which are to be treated by puncture and injection of iodoform emulsion.

Passive Congestion by Dry Cupping.—Klapps' cups, introduced for this purpose, are very useful in the treatment of tuberculous ulcers and sinuses, when the tracks are not too long. The congestion is maintained for a few minutes, then relieved and repeated several times till about ten to fifteen minutes have elapsed. This may be repeated daily.

Treatment of Cold or Tubercular Abscess.—Many surgeons of large experience in the treatment of cold abscess much prefer the treatment by puncture with a hollow needle to any form of cutting operation. This is fortunate because the needle method brings the successful treatment of such cases within the power of a much wider circle of general practitioners than would be otherwise possible.

The methods are (1) evacuation through the needle without subsequent injection of medicaments.

This treatment should be adopted if, after immobilisation and general hygienic treatment, the abscess does not spontaneously become absorbed. It may be repeated at intervals of a few weeks several times.

The sudden relief of tension seems to encourage a flow of blood to the wall of the abscess, and causes an effusion of serum and polymorph

leucocytes into the wall and cavity of the abscess. This has a curative effect.

(2) Evacuation with subsequent injection of (*a*) emulsion of iodoform in glycerine 10 per cent. (*Mickulicz*). The glycerine acts as an antiseptic, and keeps the fluid sterile. This is used when repeated evacuation is not followed by gradual diminution in size and increasing firmness of the abscess wall. The quantity varies from 10 c.c. (2½ drachms) to 100 c.c. (3½ ozs.), according to the size of the abscess.

(*b*) *Camphorated Thymol* is recommended by Gauvain for cases in which the abscess contents are caseous. Two parts of camphor are mixed with one part of thymol ; a syrupy liquid results, and this is mixed with an equal quantity of sulphuric ether—2 or 3 c.c. is a usual dose, never more than 5 c.c.

(*c*) *With Trypsin.*—This is considered by Baetsner, of Berlin, to act in the same way that iodoform does, only more powerfully. He recommends Fairchild's Injectio Trypsini—issued in ampoules of 1 c.c. The fluid contains 60 per cent. of glycerine, and he dilutes it with 10 parts of sterile salt solution (*i.e.*, 10 c.c. per ampoule). One or two ampoules are used for an injection depending on the size of the abscess. Two, three, or more injections may be required.

These fluids seem to owe their chief action to their power of exciting local congestion and leucocytosis.

Apparatus required.—A good sterilisable syringe holding about 2 ozs., to which hollow needles, varying in size from ·9 to 1·5 mm. in calibre and about 3 inches in length, can be accurately and firmly fitted. The needles should be furnished with stilettes shaped to fill exactly the oblique apertures at the point.

These all must be sterilised by boiling (the pistons if metal being dismounted), or by soaking in 1 to 20 carbolic acid, and afterwards washed in sterile water.

Some bicyanide gauze or sublimated wool and a bandage.

The operator's hands and the patient's skin must be purified with antiseptics. The seat of puncture may be anæsthetised with ethyl chloride, or by injection of Novocaine if desired. The part selected for puncture should be on sound skin, a little distance from the abscess and in a position which will not be dependent in the patient's usual posture. These precautions diminish the risk of a sinus forming at the seat of puncture. After the needle has penetrated the abscess wall and the point feels free, a considerable quantity of the contents are allowed to escape—an assistant keeping up a constant pressure on the wall. The required quantity of fluid is then injected, a few drops being injected in the track to prevent its contamination by abscess contents.

A gauze pad is laid over the point of puncture as the needle is withdrawn, and is held in place with a bandage which also maintains a light pressure on the abscess cavity. After evacuation, with or without subsequent injection, the abscess increases in size for a time, and then, in favourable cases, progressively decreases.

For parenchymatous injection of iodoform emulsion the maximum dose is 4 c.c. (1 drachm) for children, and 30 c.c. (8 drachms) for adults.

A. Treatment of Special Joints.

(1) **The Hip-joint.**—(*a*) *By Thomas's Hip-splint.*—The hip may be fixed by Thomas's hip-splint in all cases where fixation is needed, whether the patient be going about, or confined to bed. The

Fig. 135.—Thomas's Hip-joint Splint applied for a convalescent patient (*after Thomas*).

Fig. 136.—Thomas's Hip-joint Splint applied for a convalescent patient (*after Thomas*).

splint may be applied to the hip at any angle, and this may be altered as required.

One great advantage claimed for this splint by its inventor is, that surgeons at a distance from large centres can with its aid treat their patients at home "with no more mechanical assistance than can be rendered by the village blacksmith and saddler, and the poorer class of sufferers will, at a small cost, be assisted as effectually as the wealthier classes" (*Thomas*).

The following description* will serve to explain the apparatus and its mode of application :—

The Splint consists of an upright bar or stem of flat malleable iron moulded to the body, and furnished with three transverse pieces or crescent "wings," to grasp respectively the chest, the thigh, and the leg (Figs. 135 and 136). The upright "should extend from the lower angle of the shoulder-blade, in a perpendicular line downwards over the lumbar region, across the pelvis slightly external, but close to the posterior superior spinous process of the ilium, and the prominence of the buttock, along the course of the sciatic nerve to a point slightly internal to the centre of the extremity of the calf of the leg" (*Thomas*).

The material should be the best malleable iron. According to Jones the upright should be $1\frac{1}{4} \times \frac{1}{4}$ inch in breadth and thickness for an adult of 6 feet; for one of about 5 feet 6 inches it should be $1\frac{1}{8} \times \frac{3}{16}$ inch; for a boy of ten years of age, $\frac{3}{4} \times \frac{3}{16}$ inch; for a child of five years of age, $\frac{1}{2} \times \frac{1}{8}$ inch; for one of two years, $\frac{1}{2} \times \frac{3}{32}$ inch. The wings should be of the same width, and about a third of the thickness of the body wings.

Fig. 137.—Diagram of Thomas's Hip Splint, side view, to show the bend on the upright and the position of the wings (*after Thomas*).

N.B.—The walking splint differs from the bed splint in coming down only to the lower part of the thigh; in being somewhat stronger, and in having its lowest cross-bar longer (see Fig. 138).

Unless where there is marked deformity, the first moulding of the upright is to be made from the sound side; and for this purpose the patient is made to stand upright, the affected limb being raised by supports until the pelvis is horizontal.

For ordinary *subacute and chronic cases* the trunk and lower-limb portions of the upright bar are each quite straight and parallel to one another, only not on the same plane. At the level of the buttock the bar is rounded forwards at an angle of about 145° for 2 or 3 inches before being brought back to its former direction. Thus the plane of the lower part will be about 1 inch or $1\frac{1}{2}$ inch in front of that of the upper part (Fig. 137). For acute cases with distinct angular deformity, the upper and lower portions of the splint must be kept at an angle so as to fit the patient's abnormal position. As the acute stage subsides, the splint may be gradually straightened.

Position of Cross-pieces.—The upper end of the main stem is forged flat and bent over the chest-band, and the two are made fast by a single rivet. The calf band is fixed to the lower end of the main

* Taken partly from Thomas's own book and from conversations with himself, partly from an article on the uses and application of the splint by Jones, in the *British Medical Journal*, for Oct. 1, 1887.

stem in the same way, and the thigh-band, "being placed on the surface of the main stem next to the patient, is joined to it by one rivet at a point about 1 inch below the lower bend" (*Jones*). (See Figs. 135, 136, and 138.)

Length of Cross-pieces.—Each cross-piece should be long enough to embrace more than two-thirds of the patient's trunk, thigh, and leg respectively. In practice, Thomas recommends the top cross-piece to be 2 inches less than the full length of the vertical bar, the mid cross-piece to be about $1\frac{1}{2}$ inch more than half the length of the vertical bar, and the bottom cross-piece to be two-thirds of the length of the mid cross-piece. In the walking splint, however, the lowest cross-piece is equal in length to the mid-piece.

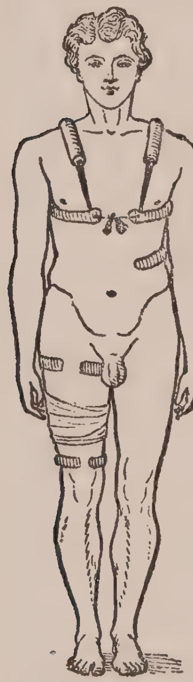


Fig. 138.—Thomas's Walking Hip Splint applied.

Mode of Attachment of the Cross-pieces.—For hospital practice each cross-bar is riveted at its middle point to the upright bar. Thus the splint as it leaves the blacksmith's hands is adaptable to either side of the body. When the splint is made for a special case, the main stem is fixed to the chest-band on one side of the middle line—*i.e.*, towards the diseased side, because the main stem lies on this side of the patient's chest. The surgeon with his wrenches only requires to give a slight rotation to the upright bar on its own axis. This twist is given just above the buttock bend, and has the effect of making the upper or trunk portion of the vertical bar look obliquely towards the opposite side, while the lower part looks straight forward. Thus for a left splint, the upper part of the vertical bar will look obliquely towards the right, and *vice versâ*.

In *adapting* the splint after its application, a rotatory tendency to any particular side is to be met by opening out the portions of the cross-pieces on the same side, and bending in those on the opposite side—*i.e.*, if there is rotation towards the right, relax the right parts and tighten in the left parts of the cross-pieces. A bandage on the leg and thigh, applied in a direction contrary to that of the rotation, is also recommended for keeping the splint in its place.

These directions apply to the fitting of splints to patients in whom there is no deformity other than that of flexion. Where there is also adduction or abduction an additional half wing should be fixed on to the upright bar between the level of the patient's iliac crest and last rib. For adduction, this wing will be on the same side as the disease, for abduction, on the opposite side. Where the extra wing cannot be obtained, one-half of the top cross-piece may be bent downwards instead.

Sometimes children whose condition requires rest in bed, try to get up and walk, when they are not being watched. To prevent harm from this, Thomas fixes on his "nurse," consisting of a piece of iron screwed on to the lower end of the upright, so as to project below the foot, and make walking more difficult and less harmful.

When the more acute symptoms have subsided, and the patient is deemed well enough to be out of bed, the boot on the sound side is raised on a patten, and crutches are provided. The affected leg thus hangs, and extends the hip-joint by its weight. Owing to the artificial rigidity of the hip-joint, the patient cannot easily sit.

For cases of bilateral disease, for one-sided disease in very young children, or wherever there is marked deformity (especially adduction), Jones recommends a double splint, or an abduction frame (Fig. 182). The distance between the two uprights is 1 inch more than the interval between the two posterior superior spines. A cross-bar joining the two uprights, just above the lowest cross-pieces, will add much to the strength of the double splint. This cannot, however, be easily applied when the two hip-joints are at markedly different angles.

Thomas urged surgeons to learn how to mould the splints to fit the patient, and figured wrenches for the purpose (Fig. 139). Two are needed. (These, as well as the double splints and abduction frames, are made by Messrs. Critchley, Liverpool.)

Fig. 139.—Wrench (*after Thomas*).

The surgeon when he has seen that the blacksmith has rightly made the general proportions of the splint, sends it to the saddler to be padded with a single layer of boiler-felt (No. 1, *i.e.*, about $\frac{1}{4}$ inch in thickness), and covered with basil leather.

The ends of the body-crescent are to be united by a strap fixed to one side, and buckling or buttoning on to the other. A brace over the shoulder of the sound side supports the splint. This brace and the secondary straps to steady it are illustrated in the diagrams (see Figs. 135, 136).

For his poorer patients Thomas used a simpler plan (Fig. 138). Each end of the uppermost cross-piece terminates in a hole about half an inch in diameter. The middle of a piece of bandage is passed below the upper cross-piece, where it is attached behind to the upright bar. The ends of the bandage, after having been twisted together for a short distance above the splint, are brought over the patient's shoulders, and are passed through the holes in the upper cross-piece before being tied together. Thus the bandage keeps (1) the splint up, and (2) fixes together the ends of the cross-piece.

The thigh and leg may be either bandaged to the corresponding part of the splint, or be fixed there with shields similar to those described for the knee-splint.

Figs. 135, 136, and 138, after Thomas illustrate the application, of the splint.

The Treatment of Adduction.—Adduction of the affected thigh necessitates tilting upwards of the corresponding side of the pelvis, in order to bring the foot underneath the body. This causes what is known as "practical" or "apparent" shortening, as distinguished from real shortening caused by diminished length of the bone or bones of the affected side or by pathological dislocation. During treatment, care must be taken to avoid adduction and to ensure an abducted or at least parallel position of the affected limb. Two forms of splint can be recommended to maintain the position of abduction—Jones's abduction frame, or Stile's abduction splint (see Figs. 182, 183).

(*b*) *By Extension.*—When it is decided to apply **Extension**, the patient must be kept in bed, lying on a firm mattress. The first thing to do is to see what position the thigh assumes when the patient's pelvis is made to lie even—*i.e.*, when the line joining the two anterior superior spines is at right angles to the axis of the trunk, and when the lumbar region of the spine rests against the bed. Whether the position of the femur be one of flexion and adduction, flexion and abduction, simple flexion, or without deformity at all, it is the one in the line of which traction is to be *at first* made. *Where there is marked flexion*, the lower limb must be raised either on pillows or on an inclined plane One objection to the inclined plane is the necessity of extending the knee while the thigh is flexed; but inconvenience from this results only when the flexion is great. *Where abduction is combined with flexion*, the inclined plane lies by the side of the other limb. *Where there is adduction*, the inclined plane should be arched to allow the sound limb to pass under it. Should the patient be restless, a long splint may be applied to the *sound* side. The plan of raising the affected limb on pillows is simple and often effective, but may fail to ensure sufficient steadiness.

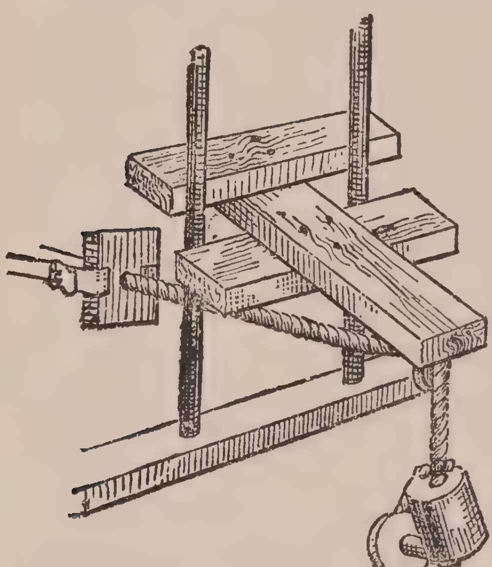


Fig. 140.—Attachment for Weight and Pulley.

Having made provision for supporting the leg, the surgeon must next adjust weight and pulley at the proper level. After the foot of the bed has been raised (on blocks, etc.) to allow the weight of the

body to act as a counter-extending force, the pulley must be fixed. For this purpose an apparatus must either be attached to the bed or be independent and stand separate. In either case it must be movable —both up and down and laterally.

(*a*) In the Royal Infirmary, Edinburgh, an apparatus, easily applied to the bars of a crib, is used in some wards. It is said to have been introduced from Liverpool (Fig. 140).

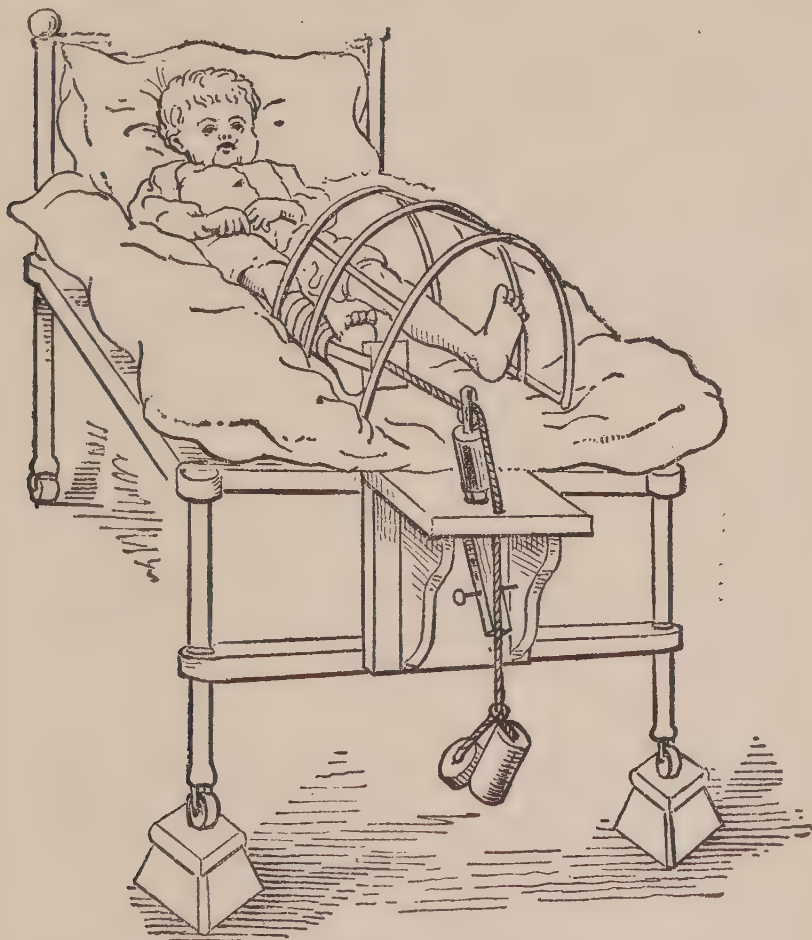


Fig. 141.—Extension with Weight and Pulley applied.

(*b*) In others, an upright bearing the pulley is lashed to the bed, or fits into a scaffold which hooks on to the end of the bed. The scaffold can be moved laterally, and the upright raised as desired by adjusting iron pins (Fig. 141).

(*c*) Marsh figures in his work on Diseases of Joints a simple stand, with a projecting arm, which can be moved up and down as required. To the projecting arm the pulley for the extending cord is fixed.

Other apparatus, probably equally simple and effective, might easily be devised.

(*d*) Where the child is laid in a crib with long uprights, the pulley may be made of an empty cotton reel, running on a pencil or pen-holder, made fast to two bars at the proper level, or suspended from above.

Materials for Extension.—For applying extension we require strong moleskin plaster, broad tape, scissors, stout needle and thread, cotton bandages, and a piece of wood a little longer than the breadth between the malleoli, or a square of wood of these dimensions with a hole in the middle, and having short straps and buckles nailed to any two of the opposite sides (see Fig. 140). Bricks or wooden blocks 3 or 4 inches high, on which to raise the bed, are also needed, and a weight, either in the form of a bag to be filled with sand or shot, or in that of ½-lb. or 1-lb. masses of lead or iron, bored in the centre for convenience in taking off or putting on. The plaster strips (one for each side of the leg) must be long enough to extend from beyond the foot to the middle of the thigh, and be as broad above as about half the circumference of the limb. They may be cut from one rectangular

Fig. 142.—Two plasters cut from rectangular piece.

Fig. 143.—Single plaster from rectangular piece.

piece (as shown in Fig. 142), or each may be rectangular, with the edges of the lower part folded in, to give greater security to the tapes which are sewn to it (Fig. 143).

Snips at the margin permit more accurate fitting of the plaster to the limb.

Mode of applying Extension.—When everything is ready, begin by shaving off hairs. Then with a cotton bandage make a few turns round the ankle, to protect the malleoli. Next heat the plaster-strips, apply them evenly to the limb, making additional snips where necessary, and cover the whole with the roller-bandage. At the upper end, turn down a few inches of the plaster so that the sticky side presents to the bandage ; this helps to give greater security.

Another method of avoiding trouble with hairs is to carry up the leg a layer of bandage, to which, and not to the skin, the plaster is applied, the whole being fixed by a second layer of bandage. When the plaster is secure, fasten the tapes to the buckles which are fixed to the square of wood below. Next pass a strong cord through the hole in the wood, and knot it to prevent its slipping out. The other end goes over the pulley, and carries the weight.* Place the limb

* The object of the wood is to keep the tapes from pressing unduly on the malleoli. A simpler way than the above is to unite the two tapes below the foot to the ends of a piece of stick, and extend by fixing to the centre of the stick a cord which carries the weight.

now in the desired position, supporting it with pillows, or on an inclined plane; adjust the pulley, and attach the weight. The amount of weight for a child of five or six years of age should be 3 or 4 lbs., and more in proportion for an adult. It is best, in all cases, to begin with a light weight and gradually increase it, till the muscles are relaxed and the patient feels comfortable. The plaster is carried above the knee, to prevent the ligaments of the knee from being relaxed by the continuous extension.

Great care must be taken to examine the patient's heel frequently. The plaster often slips downwards by the action of the weight, and carries one or more turns of bandage with it, from the narrow circumference at the ankle to the broader part below. The pressure will cause a slough if not relieved at once.

As a general rule, children in hospitals lie very quietly and make no efforts to get up. Should they be restless, besides a long splint applied to the *sound* limb, the following chest-band may be used:— "The chest-band consists of a piece of webbing, passing across the front of the chest and ending in two loops, through which the two arms are passed, and through which is threaded another piece of stout webbing, which runs transversely across the surface of the bed, under the child's shoulders, and is fastened at its two ends to the sides of the bedstead" (*Marsh*).

In some cases, where distortion is not an obstacle, fixity of the hip-joint may be attained by the single or by the double long splint, extension being produced either by the perinæal band and foot-extension, or by the weight and pulley.

(2) The Knee-joint.—The principles of treatment which have been discussed for the hip-joint apply equally to the knee, where they are more easily carried out, owing to the greater accessibility of the joint. When left to itself in a state of tuberculous disease, wherever this has begun, the knee-joint tends to become more and more flexed, till in some cases, it can flex no more. The lateral and crucial ligaments are at first softened so as to allow the tibia to be gradually dislocated backwards and rotated outwards by the flexor tendons, but, if the disease subsides, they contract and oppose the return of the bone to its old position. The primary cause of the deformity is therefore muscular. On the other hand, the deformity which occurs in acute synovitis, depends mainly on mechanical distention of the capsule by effused fluid. The joint assumes the position of greatest capacity of the membrane, which is that of slight flexion.

Although anchylosis of a joint is always a disadvantage, there is in every joint a position in which anchylosis is least disadvantageous, and there are some joints in which anchylosis is less of an evil than it is in others. Those which can, so to speak, best permit of anchylosis are the Knee, and—owing to the great mobility of the Scapula—the Shoulder. The knee, when anchylosed, should be slightly flexed; if quite straight, it is apt to be in the way, while not more useful;

if much bent, it is a useless encumbrance. Hence, and also because slight flexion is the natural position of repose of all joints, we should fix diseased knee-joints in this position, or gradually bring them back to it, if they have already left it.

Reduction of too great Flexion—(*a*) *By Fixation and Extension.*—In reducing too great flexion of the knee, the same means must be taken as were indicated for the hip. Whether the fixation or extension be employed, the deformity in acute cases must be respected in the first instance, and no effort made to overcome it until irritation and muscular spasm have subsided. Hence, instead of extending the

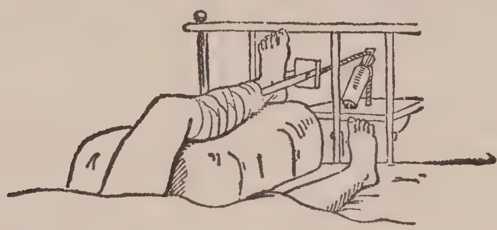


Fig. 144.—Extension applied to a Flexed Knee.

limb by weight and pulley towards the bottom of the bed, the surgeon should first support the thigh, so that the downward line of traction on the tibia is in the line of the deformity (Fig. 144).

By degrees, as irritation subsides, the line of traction may be more and more altered until it comes to correspond with the axis of the thigh (*Marsh*).

(*b*) *By Lateral Splints.*—Where there is no great deformity, some surgeons prefer well-padded lateral poroplastic, pasteboard or leather

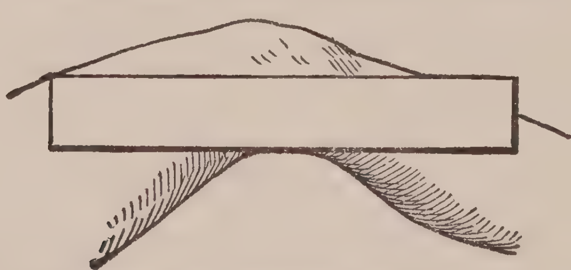


Fig. 145—Straight Pasteboard Splint for Knee.

splints. In order to limit movement it is not always necessary to shape the splints quite accurately—a broad, straight strip down each side is often enough, if well bandaged (Fig. 145); but if the greatest rigidity is needed, the side-splints must be cut to the shape of the bent knee, and made to extend from the ankle to the hip.

A simple way is to take a doubled piece of paper, long enough to go 7 or 8 inches above and below the knee, and an inch or two wider than half the circumference of the thigh. Place the limb in the desired position; lay the edge of the upper half of the paper along the line of the thigh, and cut the lower half of the paper to correspond

with the line of the leg. This gives the anterior edge of the splint; the posterior edge can easily be trimmed nearly parallel to it at a distance equal to half the circumference of the limb (Fig. 146). When the halves are opened out, the pattern for each side will be ready.

After the millboards have been cut to the required size, each half must be softened by pouring boiling water first on one side and then on the other. Tear the edges thin to make them lie evenly, and make slight transverse tears at the bend of the knee. Then,

Fig. 146.—Pattern for Lateral Pasteboard Splints.

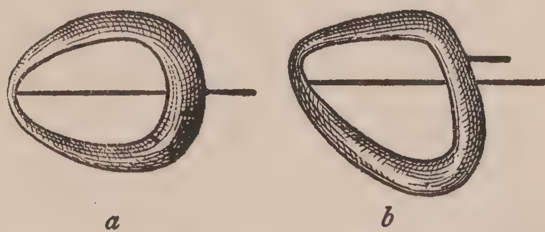


Fig. 148.—Padded Ring—*a*, For Bed Splint; *b*, for Walking Splint.

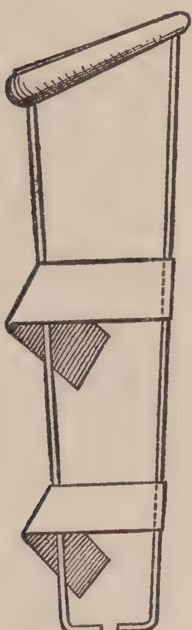


Fig. 147.—Thomas's Caliper Knee-splint.

Fig. 149.—(*a*) Staple ending; (*b*) Ring ending for Thomas's Knee-splint (*after Thomas*).

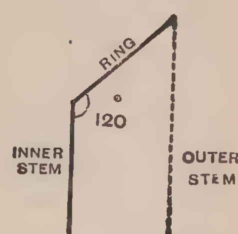


Fig. 150.—Angle of Ring on Stems.

having padded the limb well, bandage on the splint, and let it dry in position, or, having removed it carefully while in the soft state, dry it at the fire. *Poroplastic Felt*, when used, requires to be softened before the fire or over the gas before being applied. *Undressed Cowhide* may also be used. It has to be softened by soaking in cold water before being moulded to the part.

(*c*) *By a Posterior Splint* of metal, Gooch, or straight wood, reaching from the top of the thigh to the calf of the leg, and especially well padded behind the knee.

(*d*) *By Thomas's Knee-splint.*—For all cases of tuberculous knee-joint disease, unless where there is very marked flexion, there is no better splint than Thomas's Knee-splint. The objects of its inventor are to ensure immobility without external compression of the joint, and in suitable cases to permit of out-of-doors locomotion for the patient without allowing the joint to bear much weight. The mechanism of the splint is extremely simple (Fig. 147). Two light iron bars pass up the sides of the leg. Above they are fixed to a padded iron ring (Fig. 148), on which the patient sits when erect; and below they end in an ovoid ring (Fig. 149, *b*), which rests on the ground beyond the foot.* Pieces of leather between the bars support the leg and thigh behind. The limb, after being placed in position, can be easily fastened to the splint by bandages above and below the knee. A patten on the boot of the sound side makes both limbs equal (Fig. 151).

The inventor, intending that this splint also should be made by any blacksmith and saddler, has given minute directions for its construction :—

The splints are to be made out of three sizes of best round bar iron—*i.e.*, $\frac{1}{4}$ inch thick for patients up to four years old; $\frac{5}{16}$ inch thick for patients between four and eight years old; $\frac{3}{8}$ inch thick for patients from eight years old onwards.

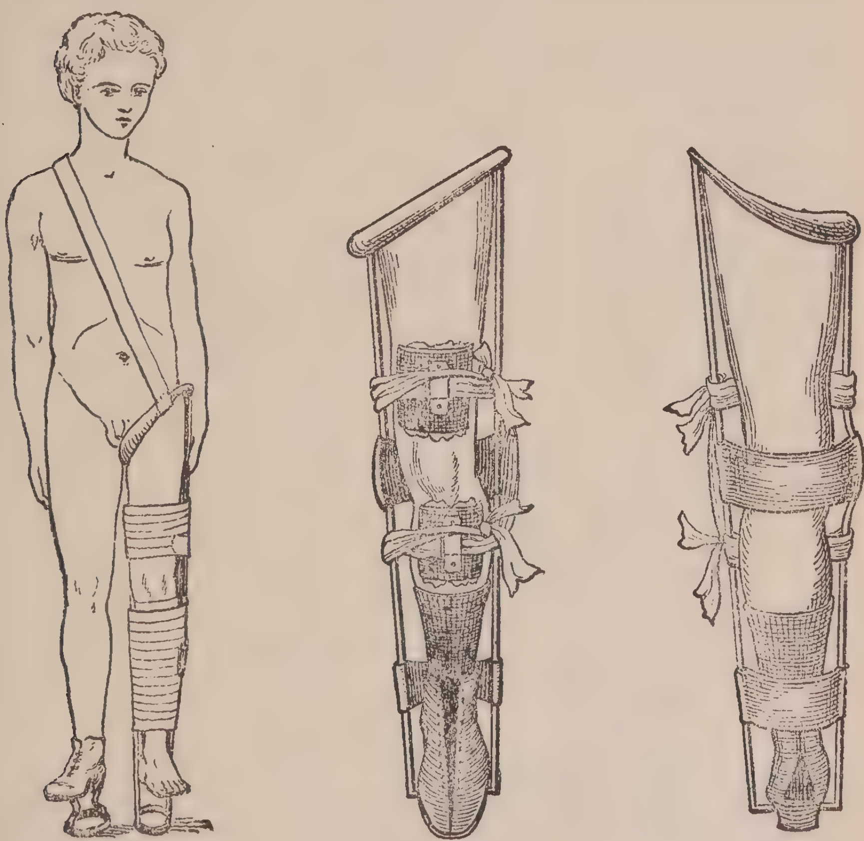
The shape of the upper or groin-ring Thomas latterly made differently for bed and for walking splints. Thus the ring of the bed splint was symmetrically ovoid, and the vertical bars were attached midway fron front to back at the out- and in-side (Fig. 148, *a*). For the walking splint the ring was flattened in front and on the inside, and bulged at the posterior and inner side, where the ischial tuberosity is situated. The vertical bars are also attached much nearer the front than the back (Fig. 148, *b*). The posterior part of the ring was also made slightly concave upwards. Thomas gave no reason for these directions. The upper ring is set by the blacksmith at an angle of 120° with the upper stem (Fig. 150).

* Latterly Thomas introduced, for synovial joint disease, a "caliper" ending to the knee-splint, instead of the ovoid ring. In this arrangement, the lower ends of the vertical bars are bent abruptly in towards one another just below the patient's heel, and are cut off short so that they may fit into a piece of brass tubing, which is sufficiently long to make the vertical bars clear the malleoli. This tube is let into the heel of the boot, by boring a hole for it in children, but in adults by cutting out a slot for it so as to allow of some rotation in walking. The upper leather must be slit in front down to the toes, and the heel part of the "upper" leather must at the same time be cut down the middle and latterly at its attachment to the heel, otherwise the patient's heel will be unduly pressed upon. The patient's heel is kept about an inch above the heel of his boot, and his weight is distributed between the splint and the balls of his toes. The sole of the boot on the sound side is thickened to equalise the length of the limbs.

For patients confined to bed the staple ending (Fig. 149, *a*) is required. The former method of ending the splint with the patten for the foot of the sound limb (Fig. 151) was latterly used by Thomas only for ankle-joint disease. In such cases a posterior splint to fix the ankle was also used (Fig. 153).

The padding is made thicker on the inside than on the outside of the ring, but the angle has been fixed upon to allow of this.

Jones now recommends the unsymmetrical ring for all cases; he describes the slope between the plane of the ring and the inner bar as forming an angle of 135°, and advises also an antero-posterior slope, so that the ischial bulge of the ring forms its lowest point. If looked at from the inner side, the anterior part of the ring would thus be set at an angle of 145° with the anterior surface of the inner bar.



a b c

Fig 151.—Thomas's Knee-splint applied—*a*, Original pattern, seldom used now except for ankle disease; *b* and *c*, Front and Back Views of Caliper-ended Splint, with improved method of fixing.

Fixing the Splint in Position.—The long leather apron between the vertical bars for the limb to rest on, and the method of fixing the limb to the splint with a bandage, had latterly been given up by Thomas. He used instead between the bars two pieces of leather, each about 2½ inches wide. One is placed so as to support the back of the calf, while the other comes behind the lower end of the thigh. After the splint has been placed in position with the ring encircling the thigh at the groin, the limb is fixed to it at two points only—

i.e., just above and just below the knee. A well-padded shield of block tin or zinc is laid over the limb at these points, and is then fastened backwards by a loop of bandage, which passes round the vertical bars on each side. The shield is perforated in two places to allow the bandage to pass through it (Fig. 152).

The splint is prevented from slipping down by a strap and buckle over the opposite shoulder.

If the knee be bent when the Thomas knee-splint is being first used, and if it be thought advisable to overcome the deformity directly, the posterior piece of leather behind the knee might be omitted. The anterior pressure strap above and below the knee would be

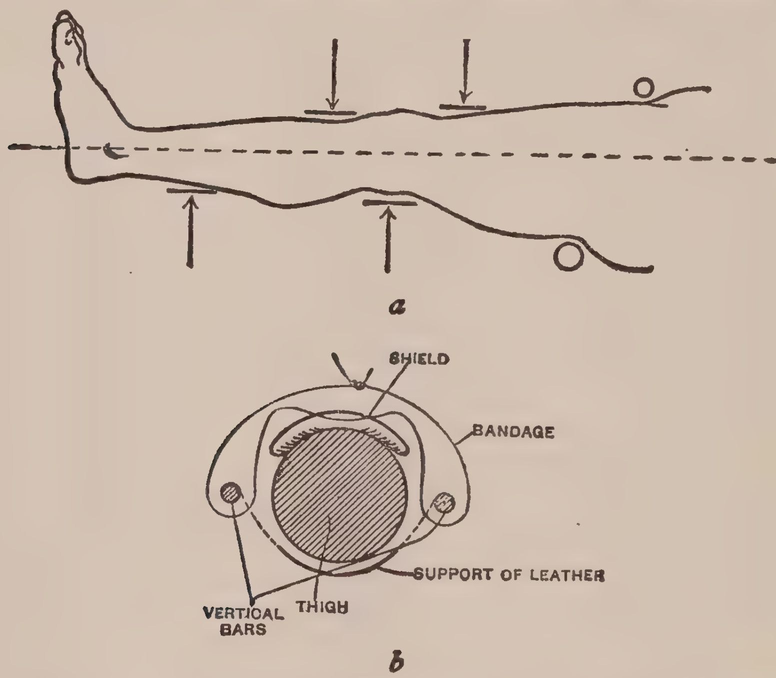


Fig 152.—Diagrams to illustrate Thomas's latest mode of fixing his Knee-splint—*a*, Side view showing the position of the shields in front and leather straps behind (*after Thomas*); *b*, sectional view showing how the shields are fastened.

gradually tightened till the leg became straight. In attempting this, however, it must be remembered that the tibia has to slide forwards on the condyles of the femur as the two bones come into line. Consequently if this sliding movement is resisted by adhesions, etc., while the straightening process is continued, the posterior part of the articular tibial surface will leave the femur, and the tibia will be forced into a plane parallel with that in which the femur lies, but posterior to it ; as if, in fact, there had been a partial dislocation of the tibia backwards in the straight position. Gradual straightening, preceded by extension in the line of the deformity, would obviate this ; and even with a Thomas splint, the tendency to dislocation

would be less if the backward straightening pressure were applied to the femur only.

In some cases, however, in which there is flexion of the knee, the foot may be gradually drawn down by light elastic traction. A handkerchief, strapping, or a well-fitting spat, is made fast to the foot, and from any of these elastic tubing or cord passes to the staple at the end of a Thomas bed splint.

A pair of calipers and angle measurer (combined) is useful to record the angles, and so watch progress.

Materials for covering and padding are the same for the knee as for the hip-splint—*i.e.*, basil leather for covering the splint and for supporting the leg and thigh, and No. 1 boiler felt for padding.

When there is unusually great swelling of the knee, the inner bar may require to be bent inwards, so that it may not press upon the swelling. When the thigh ring cannot pass the knee, owing to its being swollen, the ring may be cut or sawn through, opened out, and, after it has been passed over the knee, bent in again with a wrench.

Thomas's Knee-splint has been used for fractures and other conditions besides those of knee-joint disease. Extension, when required, can be applied to the foot by means of the lower staple (Fig. 149, *a*).

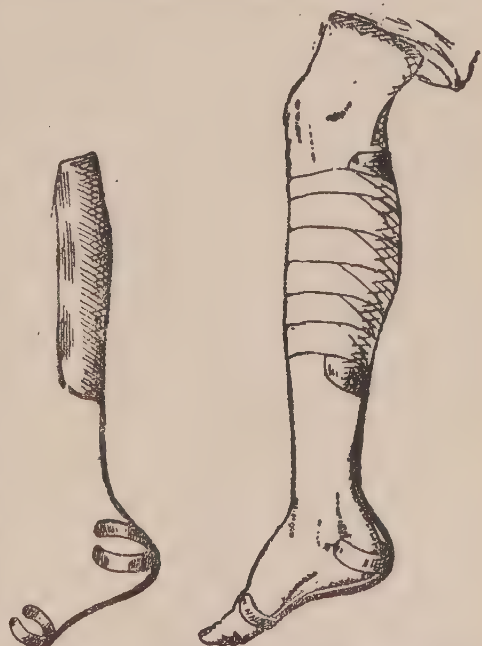


Fig. 153.—Thomas "Crab"-splint for the Ankle.

(3) The Ankle- and Tarsal-joints. — For the ankle- or tarsal-joints lateral pasteboard or leather splints will ensure fixity and compression. The foot must not, however, be put to the ground.

(*a*) In many cases *Thomas's Knee-splint*, with a foot-splint to steady the ankle, will be found useful. He used it constantly for this purpose.

(*b*) *Thomas "Crab"-splint for the Ankle.*—This consists of a piece of sheet iron bent hollow (Fig. 153), so as to fit the upper two-thirds of the calf of the leg. "To this is riveted a bar of flat iron $\frac{5}{8} \times \frac{3}{16}$, or such size as will hold the part firmly, and it is bent to approximately follow the outline of the back of the ankle and heel, and the middle of the sole of the foot" (*Jones*). At the level of the ball of the toes and of the point of the heel are fixed cross-pieces sufficiently pliable to be bent with the fingers, and which nearly encircle the foot in the one case and extend to the tip of the malleoli in the other. With sticking plaster and a bandage the leg and foot can then be made

secure to the splint after it has been padded with wool or leather (*Jones*).

(*c*) *Gamgee's method* of cutting latera' pasteboard splints for the ankle is both simple and economical of material. It may be described as follows :—Take a rectangular piece of mill-board,* which measures in length from the knee (above or below as required) to the middle of the sole of the heel, and half the circumference of the foot at the

Fig. 154.—Pattern for Paste-board Splints for Foot.

instep, *more*; and in breadth is equal to the circumference of the leg at the ankle. Along the middle of this, lay a line which extends to within half the circumference of the foot from the ends ; and from the extremities of this line, draw others at right angles to it, each running in an opposite direction to the other. The pattern of the two splints will now be complete (see Fig. 154). With a penknife make cuts in the board along the lines, and, by bending, break off the two pieces, which can be softened and applied in the usual way.

.(*d*) When the foot has to be fixed while room is left for *dressings* at the ankle, a wire-splint should be made to fit the calf of the leg, and support the bones of the leg well. To this a foot-piece is attached, but bulging laterally or posteriorly to give room for dressings at the ankle. The foot is fixed to the foot-piece by figure-of-eight turns passing under the heel, which has been previously well padded. The leg can be easily secured to the leg-piece by turns of a bandage.

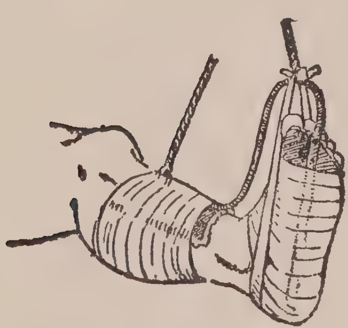


Fig. 155.—Esmarch's Stirrup-splint.

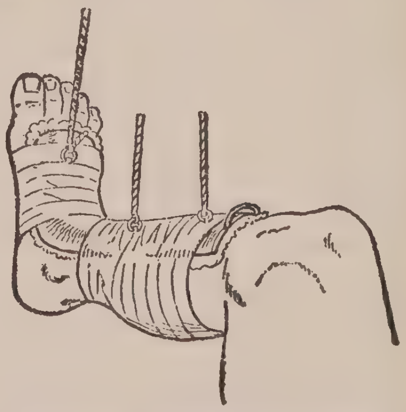


Fig. 156.—Volkman's Anterior Wooden Splint.

(*e*) *In Esmarch's iron "stirrup-splint,"* the leg-part fits on to the front of the leg, and the connecting-rod of strong iron arches over the dorsum of the foot to the sole-piece (Fig. 155).

(*f*) *Volkman's anterior wooden splint* is similar in principle (Fig. 156). MacIntyre's splint (see Fig. 115) may also be used for some cases.

(4) The Shoulder-joint can only be completely controlled when the whole arm with the hand is fixed. The simplest way is to put

* Gamgee advised the use of that which had not been finally pressed.

a good layer of cotton wool next the skin of the trunk, and bandage the arm to the side—the hand being placed on the opposite breast. When additional steadiness is required, a shoulder-cap of paste-board or poroplastic felt must be fitted to the shoulder, and bandaged in position.

(5) **The Elbow-joint.**—When absolute rest is required, the hand and fingers should be fixed as well as the elbow, for not only is the whole elbow-joint more or less involved in pronation and supination, but since the flexors and extensors of the fingers arise near the elbow-joint and pass across it, their contraction must involve some stimulation of the parts near the joint, as well as excite it by movement.

A rectangular splint is the form most usually chosen. It may be of wood, of which a set of different sizes may be kept ready with advantage. Many, however, prefer to cut the splints, as wanted, from paste-board or poroplastic felt. The following is a simple method of doing this :—

Cut out a square of paper, with the sides equal to the distance from the acromion process to the point of the elbow (Fig. 157).

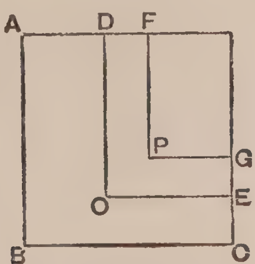


Fig. 157.—Pattern for Paste-board Arm-splint.

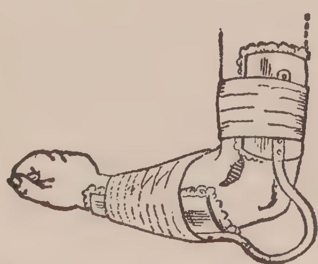


Fig. 158.—Jones's Elbow-splint.

Measure off A D, equal to half the circumference of the upper-arm, and D F, C E, and E G equal to half the circumference of the wrist. Draw D O, E O; F P, G P parallel to the sides, and cut out the pieces so marked out. These splints have next to be fitted to the arm. The larger one fits on the outside of the arm and shoulder, A D being at the acromion. The inner splint is reversed, G E being in the axilla, and D F on the forearm. If these paper splints seem suitable, copies of them are to be cut in pasteboard or poroplastic felt, and after having been softened applied to the limb. When, along with fixation, the elbow is to be left free for the application of dressings, some form of bridge splint must be used, such as that advocated by Robert Jones, of Liverpool (Fig. 158).

Thomas's method of fixing the elbow consisted in flexing the fore-arm acutely and tying the hand up to the front of the neck. He fastened a band round the wrist, and another round the neck, and drew them together till the angle between the thumb and the index finger lay against the front of the neck.

CHAPTER XXII.

JOINT-FIXATION AND FIXED APPARATUS (*Continued*).

Contents.—B. The Spinal Column—Treatment—Rest, Extension, Posture—Ambulant treatment with Spinal Supports; General Principles—The Plaster-jacket—(*a*) Size in relation to Site of Disease; (*b*) Materials for making the Jacket; (*c*) Methods of Application—Other Forms of Support—Bauer's Cuirass, Leather Collar, etc.

B. The Spinal Column.

Tuberculosis of the spine when in an active condition requires to be treated by absolute rest in the recumbent posture. The symptoms which indicate that the disease is active differ much in different cases. It may be definite local pain and tenderness; steadily increasing curvature without pain or abscess; marked rigidity of spinal muscles; raised temperature; abscess formation; indications of pressure on the spinal cord or nerves, or actively discharging sinuses.

Absolute Rest in the Recumbent Posture—*Advantages.*—The diseased bodies of the vertebræ are relieved from the superincumbent weight which crushes down on them in the vertical position, as well as from the irritation of lateral movements.

This relieves muscular spasm which is otherwise a necessary evil.

Thus local irritation is relieved, the general health improves, and the process of cure is enabled to assert itself.

Disadvantages.—The confinement to one position is irksome (to a certain extent, but less so the more it is required), and the processes of digestion, respiration, and circulation are made more sluggish. Hence the special need for fresh air, regulation of the bowels, and such tonics as iron, arsenic, iodine, or cod-liver oil.

The process of recovery is slow. As a general rule, in cases progressing well, about two years of recumbency are necessary before ambulant treatment with spinal supports can be permitted without risk of relapse.

The patient, during that time, should if possible be always in the open air. The bed should preferably be placed in an open shed, day and night, or, failing that, in a room with the windows kept constantly open.

When there is much pain extension by weight and pulley often gives relief.

When the *lumbar region* is involved the foot of the bed should be raised and the extension applied from a pelvic band, or by means of extension plasters to both legs.

When it is *the cervical region*, extension should be applied to the patient's head, while the same end of the bed is raised to allow the weight of the body to act as a counter-extending force. The patient's head in this case must rest on a pillow, and be steadied laterally by sand bags.

The attachment to the head is made from a band which surrounds the head, and passes well below the occiput, above the ears and low down on the forehead. Side straps fixed close to the ears pass to the cord of the pulley. A chin strap is irksome, and is seldom required.

When *the mid-dorsal region* is affected, the bed may be kept horizontal, and extension applied to the patient's legs and head.

Caution !—When the disease involves *the first two cervical vertebræ* the risk is greater, because of the importance of the corresponding part of the spinal cord, should it become involved ; and because of the probability of the ligaments which keep the odontoid process in position becoming softened—in which case, at any moment, instant death may be caused by the compression of the cord against the odontoid process, as the head is dislocated forwards. It is generally considered safe, when disease in this part of the spinal column has been diagnosed, to recommend at first *rest* in the horizontal (supine) position, the head being steadied as above, whether extension also be deemed necessary or not. Afterwards, some efficient head- and neck-splint, such as will be presently described, should be used.

Posture in the Recumbent Position.—Much may be done by posture to open out gradually the curvature which has resulted from the weight of the patient's body, acting through the upper healthy vertebral bodies, and crushing the diseased part down upon the healthy bodies below. There are two attitudes which specially assist this opening out :—(1) The Prone position and (2) the Supine position with over-extension at the seat of curvature.

1. *In the Prone Position.*—This may be carried out on the "prone couch," especially for the lower dorsal and lumbar regions, or horizontally on a firm mattress, with a cushion under the chest to increase the effect. Dr. Rollier of Leysin thus speaks of the prone position :—

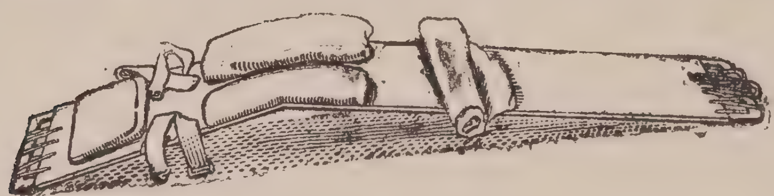
"The patient, extended on his belly, is always tempted to raise his head to see what is going on around him and to use his hands. He thus progressively recurves the vertebral column, and the recurvature constitutes, we repeat, the most rational method of straightening, since it calls upon the muscles and ligaments of the back, so important in supporting the vertebral column, and so unhappily sacrificed by orthopædic methods."

2. *Supine Position.*—Various forms of apparatus have been used to produce gradual over-extension. Of these one of the simplest and best is—

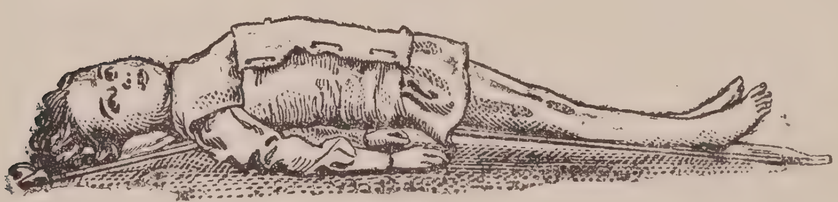
(1) The Bradford frame; this consists of a rectangular frame of metal, over which canvas is stretched. As originally introduced it was made of four pieces of iron gas piping jointed together by means of angled parts into which they are screwed.

To obviate the need for a screwed-up coupling the two ends may be made of flat bar iron bent over to form the angles, while gas piping, which forms the sides, have their ends flattened to fit the turned-down parts of the bar of iron (Fig. 159). One or two small nails jammed in will tighten up the joints, although the canvas, when in position, will of itself keep the parts together. Still more simply, the whole frame may be made of bar iron, round or flat, bent round at the angles and welded at the ends.

Length of the frame 4 to 6 inches longer than the child, breadth equal the distance between the anterior superior spines. This frame is supported opposite the seat of curvature with a few turns of bandage, and over all is stretched a firm canvas cover laced up



a.



b.

Fig. 159.—Bradford Frame of flat bar iron—*a*, Ready for use; *b*, child in position (shoulder straps not indicated).

the back with cord through eyelets, like a corset, and buckled with straps to the top and bottom bars. Careful note is then taken of the exact position of the curve of the spine, and at that point the two sides of the frame are then bent back—not much at first, but afterwards more.

Broad and firm felt pads are then shaped to fit the sides of the projecting spines. These are sewn on to the canvas, so as to leave a space between which the spines are to rest. Next a broad apron of stout cloth is shaped to cover the chest and upper part of abdomen, and this is provided with buckles and straps to hold it on to the sides of the frame. Padded straps come down over the shoulders to it from above. In many cases straps to hold down the thighs are also advisable. These are fixed in the middle of the canvas, and pass over the thighs to buckle at the sides.

The lower part of the canvas may in some cases require to be covered with waterproof cloth.

The child wears an undershirt, stockings, and diaper Once a

day it is removed from the frame, laid face downwards carefully on a pillow, while the back is dried and dusted. When fixed in this frame the child can be carried about, and the head of the frame can be raised at meal times, or at other times, to let the child have a wider outlook.

An advantage of this frame besides its simplicity and cheapness is the ease with which the surgeon can alter the angle of its side pieces. The posture of the child leads to opening out of the angle formed between the portions of the spine above and below the seat of disease, and, as improvement takes place, the surgeon can follow it up by increasing the angle of the splint. He does this by pressing forcibly on the ends while the angle is supported across a bar or otherwise. A tracing of the angle at the seat of disease should be made with a flexible metal tape from time to time, and carefully recorded.

(2) The couch or frame in use at the Hospital Maritime, Berck-sur-Mer, is shown in Fig. 160. Over-extension is produced by a pad placed beneath the mattress opposite the projecting spines.

(3) Gauvain, at Lord-Mayor Treloar's Cripple Hospital and College

Fig. 160.—Mode of fixing Patient in the Couch used at Berck-sur-Mer.

at Alton, has adopted and improved upon this frame, and has introduced an ingenious addition which he has named the "back-door splint." The object of this is to make the cleansing and care of the child's back simple, while preventing any lateral movement.

Fig. 161.—Double Thomas Hip Splint, with Headpiece, as used for Spinal Caries by R. Jones.

For particulars of this splint and its various uses see *Lancet*, March 4, 1911.

(4) R. Jones uses a frame formed by adding a well-padded head-

piece to a double Thomas's hip-splint. The child rests on a cushion of animal wool covered with basil leather (see Fig. 161).

(5) The plaster-of-Paris bed, introduced by Lorenz (see Fig. 162), and extensively used by him, has the advantages of being simple, efficient, and cheap.

"It is made as follows :—The patient is laid prone on a table. A sheet of splint wool is spread over his back, reaching from the crown of the head to the gluteal folds, and this is covered by a layer of calico. If there is a sharp angular curvature, the prominence is protected with extra wool padding. Plaster-of-Paris bandages . . . are then systematically applied to cover the whole of this area. They are laid on first in the vertical direction, radiating from the head, and also laterally, and when a certain thickness is attained cross-turns are applied. . . . When completed, the plaster bed is lifted off

Fig. 162.—Plaster of Paris Bed (*after Lorenz*).

the patient. The edges are then trimmed with a knife or strong scissors, cut out to fit the arms, and finally smoothed and rounded and bound by a starch bandage. The whole bed can now be dried in an oven and varnished. When ready for use it is thoroughly well lined with wadding covered with a sheet. . . . The bed is placed on the patient's back and secured by bandaging, and the patient can then be fully dressed. He can then easily be taken out into the fresh air with full security when lying in this bed. . . . To obtain the position of *reclination*" (*i.e.*, over-extension or backward bending) "when applying the plaster, the patient is laid face down on the table and small firm cushions are placed under the forehead, the clavicular region and the thighs. The spine then gradually sinks down between the cushions, and the position of the one under the thighs is adjusted so as to give the amount of lordosis considered proper. The feelings of the patient are an important guide in this respect.

"In the application of the *extension* plaster bed the patient is placed so that the back of the head is in a straight line with the rest of the back. He should, therefore, be laid on a flat, level cushion extending from the clavicles to the thighs, while the forehead rests on a small low cushion" (Peel Ritchie in a note to his translation of Lorenz' *Orthopædics in Medical Practice*, p. 13).

(This apparatus (Fig. 162, Fig. 13, *loc cit.*) is used by Lorenz exclusively in caries of the upper cervical spine.)

The child is bandaged into the bed. When the skin of the back is being attended to, the child is laid on his face, the bandage removed, and the plaster bed lifted off.

During defæcation the patient, firmly bandaged to the plaster bed, may be raised to the vertical position, or he may remain horizontal, provided that a portion of the plaster case round the arms has been cut out.

The Lorenz plaster bed without extension is much appreciated in Queen Mary's Hospital for Children at Carlshalton, especially for cervical caries. The bed is used at a slight slope in every case. This is attained by attaching to the bed with plaster a transverse bar of wood about 4 inches deep at the level of the patient's shoulders. This is done when the splint is being trimmed. The elevated position of the upper end gives the child a wider range of vision, and the downward slope makes it easier to keep the plaster bed dry. A band round the forehead is desirable for restless children.

Ménard recommends the Lorenz plaster bed for caries of the upper dorsal and cervical regions in order to ensure immobility. He does not combine extension with it. He considers partial suspension in the upright position (see Fig. 167) a more convenient one for fashioning the appliance than the horizontal position. This, however, will probably not hold good for private practice. A dry gauze bandage applied round the plaster bed while still soft and plastic helps to ensure an accurate fit till the plaster has set.

Ambulant Treatment with the Aid of Spinal Supports—*Advantages.*—The child is able to take some exercise, and is stimulated mentally and physically. In many circumstances it can be kept more constantly in the open air.

Disadvantages.—The diseased parts cannot be kept at such complete rest. Therefore this treatment is only suited for convalescent cases.

Objects aimed at by use of spinal supports—

(1) To restrain spinal movements and so diminish muscular spasm.

(2) To brace back the vertebral column, and so transfer the weight of the upper part of the patient's trunk from the diseased bodies to the corresponding pedicles, laminæ, and spines. In this way to relieve the tuberculous foci from pressure.

It is no longer considered possible to relieve the spinal column at the seat of disease from all superincumbent weight. Hence Sayre's jury-mast may be discarded, also all appliances designed to convey the body weight from the axillæ to the pelvis.

Principle underlying Mechanical Supports.—This may be said to consist in controlling efficiently the portions of the spine above and below the disease (*Ménard*). Thus, whether made of plaster of Paris, poroplastic felt, and such like materials, or of iron or steel with straps and belts, certain parts of the body have to be grasped by the appliance. In all cases the lower fixed point is taken at the pelvis, while the upper one varies with the part affected.

In the fitting of plaster-of-Paris jackets Ménard recommends that the jacket should extend from the pelvis—

Fig. 163.—Showing extent of Plaster of Paris Jacket for Tuberculous Disease of Mid-dorsal Region (*after Ménard*).

Fig. 164.—Finished "Minerva" Jacket (*after Ménard*).

To the *Sternal notch*, passing *under the axillæ*, but not round the shoulders or neck, in disease of the *lumbar* or *lower dorsal vertebræ* (Fig. 166, see Ménard, Fig. 190).

To the *neck*, but *stopping short of the chin and occiput*, in disease of the *mid-dorsal region* (see Fig. 163) (*i.e.*, Ménard, Fig. 198).

To the *neck, chin, and occiput* in disease of the *upper dorsal and cervical* regions. This is known as the "*Minerva*" *Jacket* (Fig. 164) (*i.e.*, Ménard, Fig. 195).

Modifications of the Minerva, designed to give greater freedom to the chest and abdomen, are recommended by Gauvain (see Fig. 165), and he has devised a modification of the method of controlling the head which seems at once more efficient and less inconvenient for the patient. This he has named the "Fillet" (Fig. 169).

Fig. 165.—"Minerva," after removing part to free Respiratory Movements (*after Gauvain*).

Plaster-of-Paris Jackets have the advantage of being applicable by a medical man without any complicated apparatus. A certain amount of practice, however, is required, and careful attention must be given to detail in order to ensure success.

A well made jacket is strong, light, and porous. The materials are cheap, and the jacket does not take long to apply. It cannot be taken off and on, but this, which is an advantage in some ways, is a disadvantage where cleanliness is not attended to in the child's home. To obviate trouble with vermin in such cases, the undershirt should be steeped in a hot saturated solution of boric acid and dried before application, and directions should be given to the mother for the free use of Keating's powder afterwards under the edges.

Sayre, who introduced plaster jackets, recommended ample padding for bony prominences, and a "dinner pad" laid over the stomach during the application of the jacket, but afterwards to be removed. The "dinner pad" or its equivalent in the form of a large window cut out over the chest and abdomen is still used, but bony projections are now dealt with differently. The soft material which lies next the skin is uniform in thickness, but the plaster case is now well moulded, while still soft, to the iliac crests and clavicles. It is cut out entirely over the marked projections of the spines.

(*b*) *Material of the Plaster Jacket*.—The material with which the plaster is to be incorporated, whether as bandage or in layers, is "some loosely-woven material, such as cross-barred muslin, mosquito-netting, or crinoline." There is nothing better than the white "butter cloth" used for dressings. For bandages, cut it into strips 3 yards long and 6 inches wide.

As substitutes for pure plaster of Paris, a mixture of five parts of finely ground Portland cement with 95 parts of plaster of Paris furnishes a light and strong bandage, while dextrine and plaster equal parts, or one part of dextrine to two of plaster of Paris, makes a tough and durable bandage, which, however, is slower in setting than one made with pure plaster of Paris, or plaster and cement.

To work in the plaster, take a quantity of freshly baked plaster of Paris in a bowl; spread a newspaper over any flat table or board; now lay one end of the bandage on the table, and having sprinkled plaster freely over it, rub it in with the hand; roll up *loosely* with the fingers the part of the bandage thus treated, and proceed with a new part, which is to be in turn rolled up. Repeat this until the bandage is finished. Several may be made at the same time. Unless the roll is quite loose, the water will not enter freely into it when it comes to be soaked for immediate use.

Gauvain recommends the following method of rolling a plaster-of-Paris bandage. He uses "wide-meshed book muslin, and after having frayed the edges, he rolls up the piece selected for the bandage. One end is placed in a bowl of dry plaster." The left hand is placed down on this strip "of muslin, which is then drawn underneath the left hand, and folded over with the fingers of the right hand" till the whole bandage is rolled along with dry plaster.

Application of the Plaster Jacket.—When the surgeon has decided that recumbency is no longer necessary (see p. 240) he makes arrangements for allowing the patient to go about with a spinal support. The extent of the grasp taken of the spine by the mechanical support has been indicated on p. 246, and the surgeon decides accordingly.

If the child has lain for long horizontally it is advisable to accustom him to the upright position for a few days before applying any jacket which entails suspension. This can be done by tilting up the frame on which he lies for several hours a day. Otherwise he may become giddy or even faint during the application.

Gauvain recommends also that before a jacket is applied the child's bowels should be well emptied, and a light diet given for a day or two, so as to lessen the tendency to flatulence.

Apparatus required.—About a dozen plaster-of-Paris bandages, a pail of tepid water, a little dry plaster, and old newspapers to cover the floor.

The parts of the child's body to be included in the plaster case are to be protected by a soft undervest. It is fastened below over a

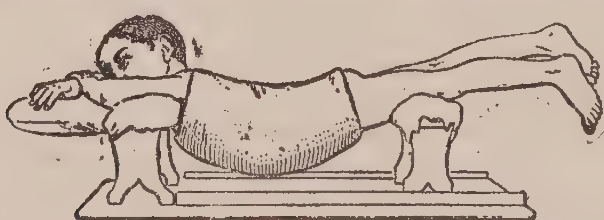


Fig. 166.—Application of Plaster of Paris Jacket in the Horizontal Position for Disease in Lower Dorsal and Lumbar Region (*after Ménard*).

perineal pad, and covers the whole head for one of the higher cases, a hole being cut out opposite the mouth and nose. For lower cases its extent is less, but always more than that of the case itself.

Instead of a woven flannel vest or semet, one shaped out of soft material, and tacked together with the seam outside may be more easily obtained, especially by the higher jackets. A layer of wool, about ½ inch thick, is laid outside the undershirt, and is tacked lightly in position. It should cover the lower part of the chest and upper part of the abdomen, and is to be afterwards removed. Gauvain directs that this pad should not extend to the top of the sternum and clavicles, since it is desirable to prevent these parts from coming forward when the jacket has been applied.

(*a*) *Jacket for Lower Dorsal or Lumbar Caries.*—This may be simply and efficiently applied in the horizontal position, as recommended by Ménard, and illustrated in Fig. 166.

(*b*) *Jacket for Mid-Dorsal Caries.*—As this extends on to the neck, the patient should be suspended.

Method of Suspending Patients.—The object in view is to lift the patient by the head as far as can be comfortably borne. The toes never leave the ground. No axillary straps are used, but the patient

may bear a little of his weight with his arms. The sling for the head becomes incorporated in the case if need be, and is, therefore, made from a calico, strong muslin, or other firm bandage, as follows :—A portion about 4 feet long, having been doubled, is tied in a simple knot about 6 inches from the doubled end. This leaves the two free ends hanging from the knot, beyond which is a loop. The knot is laid in front of the patient's ear, one free end passes under the occiput, and the other over the chin, and the two are then knotted in front of the other ear The position of the knot is then adjusted till the

Fig. 167.—Application of Plaster of Paris Jacket. Mode of partially suspending Patient (*after Ménard*).

knots lie opposite the temporal region on each side when the sling is lifting the patient partially off the ground. The second knot is then completed, and one free end is passed through the first loop and tied to the other end The sling may be suspended by a single (see Fig. 167), or by a double hook, which is attached to a strong cord passing over a pulley. A fixed point for the pulley may be provided by a tripod or other apparatus for the purpose, but in default of these the surgeon must devise a substitute, as, for instance, a bar supported horizontally between two strong clothes' screens.

Application of the Plaster Bandage.—The child having been gradually raised by the sling as far as can be comfortably borne for ten to fifteen minutes, the surgeon and his assistant place themselves on opposite sides of the patient. A second assistant takes one of the dry bandages and places it carefully in the pail of water, end up so as to allow the air bells to escape. After about a minute's soaking he grasps the bandage by the two

Fig. 168.—Application of Plaster of Paris Jacket. Moulding round Pelvic Brim (*after Gauvain*).

ends, and having gently squeezed out the water with as little loss of the plaster as possible he hands it to the surgeon, and at once inserts another bandage, and so as to keep up the supply. The surgeon begins by encircling the patient's chest and abdomen with the bandage. The first assistant smoothes the bandage and rubs in the plaster at the back, while the surgeon does the same at the front. A common mistake in fashioning plaster jackets is to spread a layer of plaster between each layer of bandage. This makes the jacket both heavy and brittle. There should be enough plaster

to fill the intertices of the muslin and weld the various layers together, but no more. Hence the value of rubbing and smoothing during the application.

When the direction of the bandage has to be changed instead of a "reverse," Gauvain recommends the surgeon to make a pleat. This is done by folding the bandage back on itself for an inch or two and carrying it forward again in the required direction. This manœuvre is done quickly and requires practice. It enables the surgeon to strengthen the case at special parts if so desired.

"Usually two, or sometimes three, 6-inch bandages, 4 yards long, are all that is necessary to encircle a patient's trunk efficiently. By the time these three bandages have been applied, the first bandage is set sufficiently to enable the moulding to the pelvic brim to be undertaken (see Fig. 168).

"The greatest possible stress is laid on this procedure, for it is from the fixed pelvic base that support for the jacket must be obtained. A jacket, which is not moulded around the pelvic brim, is useless and inefficient. In the moulding, care should be taken that no pressure is made on the bony pelvis, but on the soft abdominal wall above this bony pelvis. The shoulders, well pressed backwards, are incorporated by simply passing the bandage backwards and forwards from chest to back, until a sufficient number of turns have been made to give the support required. These shoulder bandages are next held in place by a bandage, starting from below the axilla and encircling the trunk twice in this position, and the jacket is well moulded on to the clavicles. The bandage can then be continued on to the neck.

"*The Neck.*—The neck of the patient is encased in plaster by passing the bandage several times around it, and pleating it at least twice in each circuit of the neck. This bandage must pass from the neck, around the head, under the chin, and under the occiput; it must, in fact, encase the head completely except the face, which alone is not encircled in the plaster. It should specially be strengthened posteriorly. The jacket thus applied will hold the patient firmly and absolutely, and the lesion will remain immobile. In taking in the head, the surgeon must most carefully mould the plaster under the chin, under both mastoid processes, and around the occiput.

"The jacket completed, windows are marked before the patient is taken down from the gallows. It will be seen that a large ventral window will efficiently prevent any interference with respiration and digestion, and this window should be cut out on the second day after the plaster has been applied, providing the patient's condition has not made it necessary to make it earlier. The plaster involving the head may be cut away below each ear, so that it will only press up against the occiput, the mastoids, and the chin. In its lower part it may be cut away so that it will rest on the pelvis, and allow free flexion of both thighs" (*Gauvain*). "If any angular curvature exists a window should be cut out over the curvature, so that this part of the spine may be kept under observation.

"At the first trial of putting on plaster, a low jacket should only be attempted, because it is desirable that the jacket should be applied as rapidly as possible for the patient's comfort, and the difficulties in putting on a high jacket are so considerable, that such an apparatus should never be attempted, until considerable experience has been obtained.

"After the patient is taken down, the jacket should be left untouched for two days before it is cut out, so that the set shall really be firm, and all the surplus water in the jacket sweated out. Sometimes, it is found that the patient's pulse during this period is a little irregular, but that is a rare occurrence, and has never been sufficient to cause any anxiety. One common complication, which will occur unless the precautions already alluded to have been taken, is persistent vomiting. This, I believe, is always caused by undue distention of the abdomen, and can be avoided by dieting the patient before the application of the jacket, and until windows are cut out. It can be relieved immediately by cutting out extensive windows, but the premature cutting out of the ventral window is undesirable, if a sufficiently strong apparatus is to be obtained. Accompanying this sickness is excessive pain, if there is undue distention in the tight jacket; this is also relieved by cutting out the window, but it will not occur, if attention has been given to dieting and the bowels.

"Two days having elapsed after the application of the plaster, the apparatus is now ready to be finished and the windows are cut. An ordinary penknife is quite sufficient for the purpose, and after a little practice it will be found that the windows can be made expeditiously. It facilitates the cutting out of these windows, if the knife is constantly dipped in water. Acetic or other weak acids have been recommended for application to the plaster previous to the windows being cut, but I do not recommend the employment of these, as they render the jacket friable, and are quite unnecessary after a little skill has been obtained. Good shears are sometimes of assistance, but the ordinary shears with long blades are useless. Short blades and powerful handles giving sufficient leverage are recommended.

"The plaster having been cut where indicated, the vest is turned back over the plaster, and fastened down to it by the application of plaster-cream, which is spread evenly all over the jacket until a smoothly polished surface is obtained. The plaster-cream is lightly rubbed with wet hands, until a high polish is obtained. Plaster-cream can be made by adding about three parts of water to five parts of plaster. The result of its employment will be highly satisfactory, as a beautiful polish is obtained, and the life of the plaster is prolonged. The plaster may be kept nice by being scraped a little, perhaps once monthly, and again polished, and in this way, with reasonably clean patients, plaster jackets can be kept on almost indefinitely.

"*Sores under the Plaster.*—If the plaster has been applied very carefully sores are not likely to occur, but their onset can even be

detected before they actually form, because skin germs multiply where sores are about to occur, and give off a peculiarly unpleasant odour, suggestive of the smell noticed from the skin of people of uncleanly habits. If then, as soon as this odour is noticed, a window is cut, the formation of a sore can be prevented. A curious point about these sores is that they are usually painless, and quite often it will be found that the patient is unaware of their existence, and a considerable amount of sloughing may take place before they are detected. Their formation, however, is very rare, and should not occur if the patient is efficiently nursed.

"*The Fillet.*—The high jacket ('Minerva'), the application of which I have already described, is commonly used on the Continent. While very efficient, there are some objections to its use. It does not ensure complete immobility, because of the necessity of mastication,

Fig. 169.—The "**Fillet,**" applied for **Cervico-dorsal Caries** *(after Gauvain).*

and the difficulty of mastication is greatly increased owing to the necessity of raising the head instead of depressing the jaw while eating. In young children it may, to a certain extent, deform the jaw, and in male adults the growth of the beard is an intolerable nuisance.

"To obviate these drawbacks, I have devised another form of high jacket, which has all the advantages of the 'Minerva,' none of the disadvantages, secures better immobilisation, and is, therefore, more efficient. To this jacket has been given the name 'The Fillet' (see Fig. 169), owing to the fact that the head is maintained immobile by retaining a plaster band in the frontal region. Patients with such an apparatus can eat and shave with perfect comfort. It need hardly be emphasised again that this jacket must be moulded most carefully and thoroughly under the occiput and mastoid" (*Gauvain*).

Furneaux Jordan's Laminated Plaster Method, as described by the author in the *British Medical Journal*, July, 1882, is as follows:—

"The surgeon first determines how much of the limb or trunk it is well to cover. A pattern is then cut—one of the layers of checked muslin does very well for this purpose, as it is stiff enough to keep its shape, and is easily marked with a pencil. Afterwards, other pieces of muslin are cut of the same size and shape. Six or seven layers make a good average splint; three or four will do for a child; eight or nine may be needed for a heavy, restless, or delirious patient. The first layer is laid flat on the table, and sprinkled with a layer of good dry powdered plaster, which is smoothed over with a spatula or paper-knife; on this, with its margins corresponding, is placed the next layer of muslin, which in its turn is sprinkled with plaster. The process is repeated until all the layers are in place. The splint is then slowly and carefully folded or rolled up and kept dry, ready to be dipped in water when wanted. The water—let this be well understood—immediately passes through any number of layers of muslin and plaster, thoroughly drenching them both in less than sixty seconds.

"The part to be encased is drawn into position, and held so until the plaster partially sets. If the fingers of the extending hand be in the way, as when the foot is included in the splint, a temporary sling of webbing or plaster over the instep and heel may be used, which can be drawn out or relaxed afterwards. A flannel bandage, or layer of wadding or jersey, is next applied without traction. The splint is now dipped in hot water (hot for comfort and for more rapid setting) for a minute or so. When taken out, it is very gently squeezed, being still quite sloppy and limp. When the water is pressed out too freely, the sheet will be sandy, friable, and difficult to apply. The splint is then unfolded, and drawn out in a perfectly soft and smooth sheet; it is next put under the ailing part, and simply folded over. The overlapping margins instantly and firmly adhere to each other. Traction should be most carefully avoided; perfect neatness is enough. The layered plaster splint is applied with as much ease, as regards limpness and adjustability, as is a fomentation; but it is a fomentation which sets, and, with rock-like firmness, lastingly holds the part in any given position.

"In the upper limb, the laminated sheet should be large enough to overlap 2 or 3 inches; in the lower limb, the overlapping should extend to 3 or 4 inches; in the trunk, to 5 or 6. A pair of strong sharp scissors easily trims the splint while it is still wet. . . . Windows, scollops, or openings of any kind, do not weaken a splint; and it is better to make them opposite bony prominences, breasts, and other compressed parts, as well as opposite abscesses, wounds, and compound fractures."

After this general description a very few words are necessary to explain the spinal splint. This, as the drawing (Fig. 170) shows, is made of three pieces of laminated plaster, two in line with one another, and one overlapping their adjacent margins, and superficial to them (this is brought out on the pieces shown in the drawing as folded on to the patient's chest, but it is not properly illustrated on the

patient's right side). This method is admirably adapted for supporting the back in cases of recent fracture of the spine, where suspension is inadmissible, although support is greatly needed. The patient is carefully rolled over on to one side; the splint, after being soaked, is rolled half up and laid against his back, he is then rolled over the splint on to his opposite side and the rolled up part of the

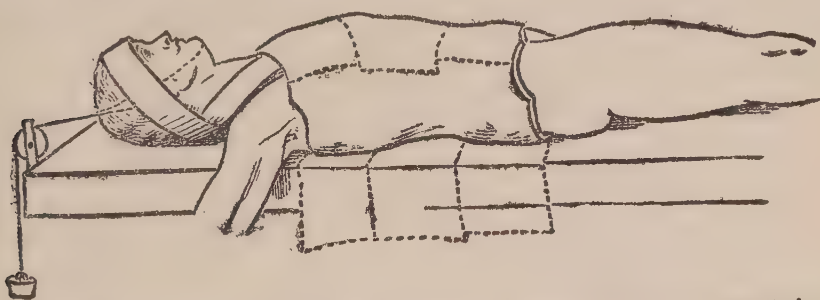


Fig. 170.—Furneaux Jordan's Laminated Plaster Splint for the Spine (*after F. Jordan*).

splint is opened out. He now lies on the splint, and the surgeon has only to draw the ends over and smooth them down. The method is exactly like that of changing a sheet under a helpless patient. The other applications of the same method have been introduced at the same time to prevent the need for repetition afterwards (Figs.

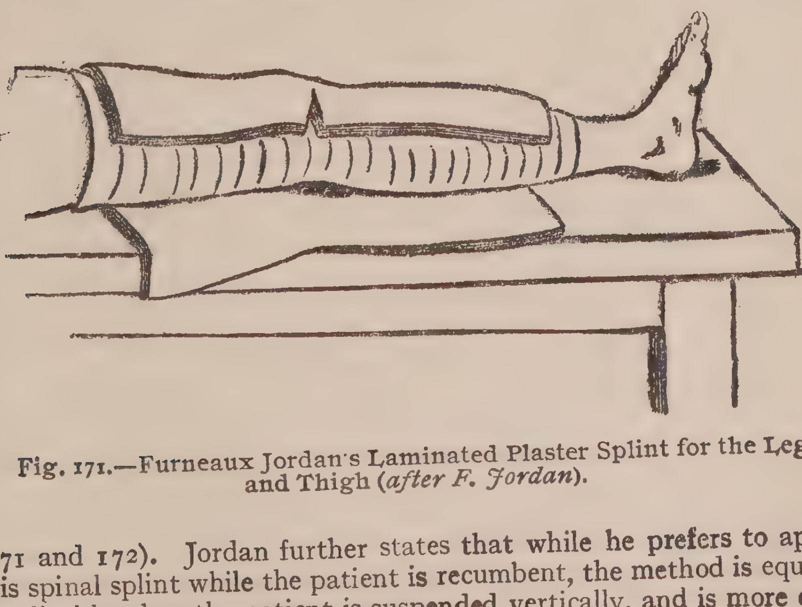


Fig. 171.—Furneaux Jordan's Laminated Plaster Splint for the Leg and Thigh (*after F. Jordan*).

171 and 172). Jordan further states that while he prefers to apply his spinal splint while the patient is recumbent, the method is equally applicable when the patient is suspended vertically, and is more easy to carry out than Sayre's.

Thomas's Modification of Bauer's Cuirass.—This is essentially a rigid back support extending from the pelvis to the shoulders and

fastened on with straps. It is simple and cheap; any blacksmith and saddler could make it under the surgeon's directions. Its straps can be modified to suit the needs of a growing child, and it readily permits of attention to cleanliness (Figs. 173 and 174).

The frame is of bar iron, $\frac{3}{16}$ of an inch thick by $\frac{3}{4}$ of an inch broad for a child of from four to eight years, and thicker in proportion for older people. It is welded into a single piece, and lies against the patient's body as follows:—At the bottom it reaches as low as the sitting posture will allow, and thus extends across the sacrum from the space just posterior to the great trochanters. From this point on each side it passes up on the outer side of the posterior superior spines of the ilium, and thence inwards, to lie close to the spinal column in the lumbar and lower dorsal regions. As it ascends further it diverges slightly outwards towards the posterior fold of the axilla, and is then bent inwards till it runs across to meet its fellow of the opposite side about the level of the 7th cervical vertebra. As the figure shows, the frame is slightly broader above than below. It is forged so as to lie flat against the patient's back.

Fig. 172.—Furneaux Jordan's Laminated Plaster Splint for the Thigh and Pelvis (*after F. Jordan*).

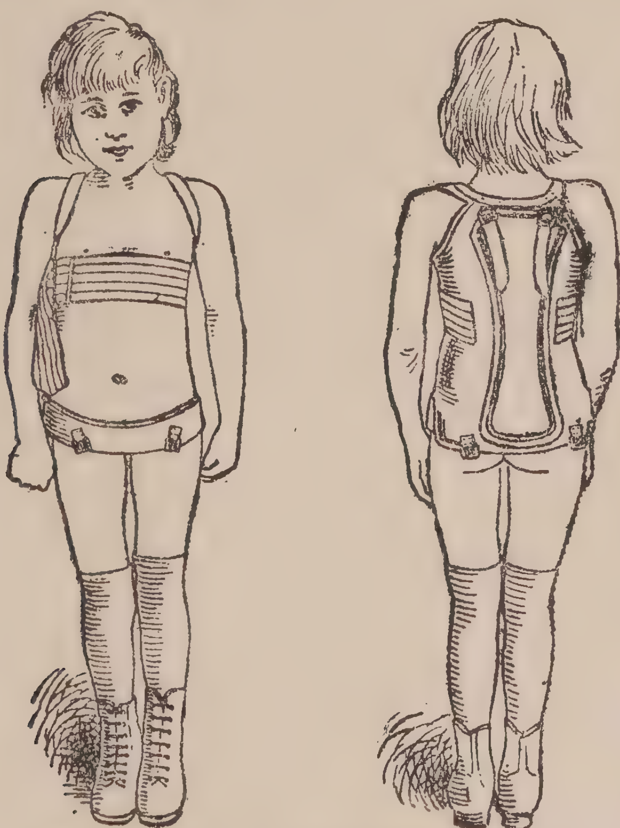
To measure for the splint, the patient sits upright, and the length of a perpendicular, dropped from the level of the 7th cervical vertebra to the seat, is first taken, as giving the length of the upright bars. The cross measurements at the wider and narrower parts, as already described, can then be noted. The patient is next laid on his face, and the outline of the spine recorded by means of a flexible tape of pure tin or lead. It is, of course, to be remembered that the angle is greater over the spines than at the sides where the bars run.

When the blacksmith has made his frame to lie flat against the patient's back, the services of the saddler are called for. A piece of fairly rigid leather is placed beneath the frame and extends beyond it all round. Beneath the leather, and extending a little beyond it in turn, is a piece of saddler's felt. The felt and the leather are sewn together, and the frame, and afterwards the straps and buckles, are fastened to both. The whole is then covered with basil leather.

Straps and Buckles.—The cuirass is fixed to the pelvis by a broad leather strap lined with felt, which passes round between the great trochanter and the crest of the ilium on each side. Perineal straps

are fixed behind, just below the attachments of the pelvic belt, and they pass between the thighs to fasten to buckles on the pelvic belt, about opposite the middle of Poupart's ligament.

From the middle of the cuirass a strap of webbing is fixed on each side. This passes round the lower part of the chest and buckles on one side. The shoulder straps on each side are fixed at the junction of the neck and shoulder and at the lower border of the axilla. The shoulder and perineal straps are made of leather lined with felt, and covered with basil leather.



Figs. 173 and 174.—Thomas's Modification of Bauer's Cuirass (*after Jones*).

If the angle of curvature projects sharply, the leather and felt over it may have to be split, so as not to press on it. The angle may also be protected from pressure as the patient lies by a longitudinal bar of iron over the spines

Where it is necessary to fix one or both thighs, additional bars can be fixed on to the lower part of the frame with cross-pieces to encircle the thigh above the knee. Where the neck has to be fixed, a Thomas, or other neck collar, may be worn in addition to this cuirass, or an additional piece may be fixed to the upper part of the frame. This

piece bears a cross-bar curved to fit the occiput and ending in straps which pass from just above the back of the ears round the forehead.

(The account of this splint is taken from Jones and Ridlon's article in the *Provincial Medical Journal*, December, 1892.)

Methods of Support in Cervical Caries.—When a "Minerva" or "Fillet" support of plaster of Paris is not applicable for any reason one of the following supports of leather or poroplastic felt may be employed. Some surgeons may prefer Furneaux Jordan's laminated plaster splint as being more easily applied. Treve's splint for steadying the neck might ensure sufficient rest in some cases. It has the merit of being very light.

(*a*) *Owen's Leather Collar.*—One described by Owen has been long used in the Great Ormond Street Hospital (Fig. 175). It is made of "undressed cow-hide, and is moulded on after being soaked in a pail

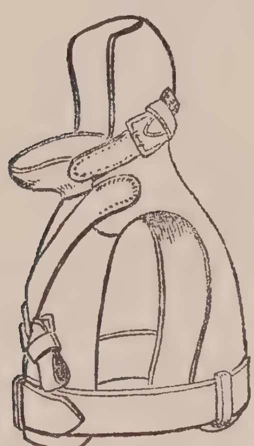


Fig. 175.—Leather Collar for supporting Head (*after Owen*).

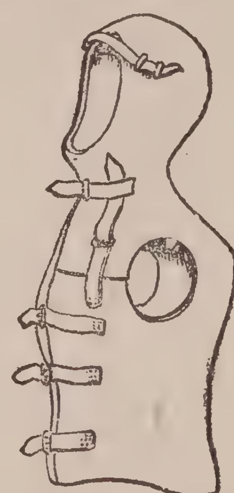


Fig. 176.—Poroplastic Support for Head and Neck (*after Walsham*).

of hot water. The hardened case is afterwards lined with chamois leather, and the front and back halves are made to overlap on the shoulders, and are fixed together by straps and buckles."—*British Medical Journal*, Oct. 31, 1885.

(*b*) *Walsham's Combined Jacket and Collar of Poroplastic Felt* (Fig. 176), described in the same number of the Journal, is somewhat similar to the above, but encloses the head and chest more completely. It is like a combined helmet and cuirass, and has been used with success.

(*c*) *Jordan's Cervical Support.*—We cannot omit mention of Furneaux Jordan's "laminated plaster jury-mast (Fig. 170), which fixes the head and neck in one immovable block—so immovable that, if the finger move the spine of the ilium, the head is moved at the same time; or if the head be turned, the trunk is turned with it. The

jury-mast is a layered strip (eight to ten layers) about 45 or 50 inches long by $2\frac{1}{2}$ or 3 inches wide. The deformity, if any, of cervical caries should be alleviated by horizontal mid pulley-extension, maintained by a chin and occiput sling for some weeks or months before the jury-mast is put on. It is applied thus :—The patient reclines on a narrow table and a mattress, with no pillow, pulley-extension with webbing being kept up until the plaster sets. The prepared multiple strip, rolled up at each end, after being dipped a few minutes in water is unrolled, stretched, and smoothed ; its centre is then applied to the forehead, well away from the eyes ; the two ends are next carried to the back of the neck ; when they cross, one end being carried under the neck first, then the other. They are drawn firmly enough to closely embrace the head and back of the neck ; the ends are then brought forward and cross each other again in front of, or near, the sternal notch, where they are lastly fastened by a plaster jacket laid ready to be put on in the manner I have just described (p. 254). Before the laminated strip is applied, the hair is cut short, and a double strip of flannel, with cotton wool about the ears, is applied by the same method as the plaster strip. Before the strip sets, its upper margin should be partially everted from the angle of the jaw to the sternum, giving thereby much ease to the neck, especially when the jaw is moved."—*British Medical Journal*, July 15, 1882.

With regard to the disputed relative merits of plaster of Paris or poroplastic felt, the latter if well fitted, is neat, light, and strong, and is also porous ; but it must be fitted on by a skilled workman, and often requires a model, or cast of the part. The former is much cheaper, nearly as light, equally strong and porous, and perhaps more lasting Every surgeon or house-surgeon can apply a plaster-of-Paris jacket for himself.

(*d*) *Splint for Steadying the Neck* in cases of enlarged cervical glands, wounds of the neck, etc. In the *Lancet* for 1886 (vol. i.), Treves drew attention to the importance of giving rest to the neck as a factor in the treatment of such cases. He figured and described a splint, which he had had made by an instrument maker, to limit the movements of the head and neck.

The principle is an excellent one, and may be carried out in several ways without the aid of an instrument maker.

(1) By means of a splint of strong galvanised wire. This splint which the surgeon can make for himself is a modification of that recommended by Treves. The wire for adults should be " the size 8," for children " size 10" (wire-gauge) in thickness. It should at first be shaped out of one piece, as shown in the diagram (Fig. 177). The length of wire required is measured as follows :—With a piece of string, tape, or bandage, begin at the centre of the forehead and pass round one side to the occiput, thence following the contour of the body to the 7th cervical spine, behind the shoulder to the outer end of the clavicle, vertically downwards to the waist, and across to the opposite side. This gives the length for one side—double it, and add

a few inches for twisting the neck part and cut off a corresponding length of wire. The wire is then to be bent into shape with the hands and a pair of strong pliers as follows :—Find the middle of the wire by balancing it on the forefinger, and put a mark there. Now at a point on each side of this, equal to the distance of the occipital protuberance from the back of the ear, bend the wire back on itself to form the head rest. Twist the two ends together where they meet again opposite the central mark. Continue the twisting for a distance equal to the length of the patient's neck, then bend the ends out separately so as to follow the line of the shoulders, and at the level of the outer ends of the clavicles turn them vertically downwards. At the level of the patient's waist, bend them across towards one another and end by a whipping of cord or wire.

At first the splint is made on one plane. It has next to be shaped to fit the patient. The first time this is done a little patience is

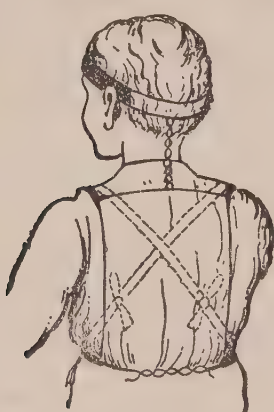


Fig. 177.

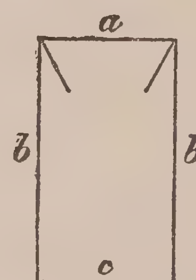


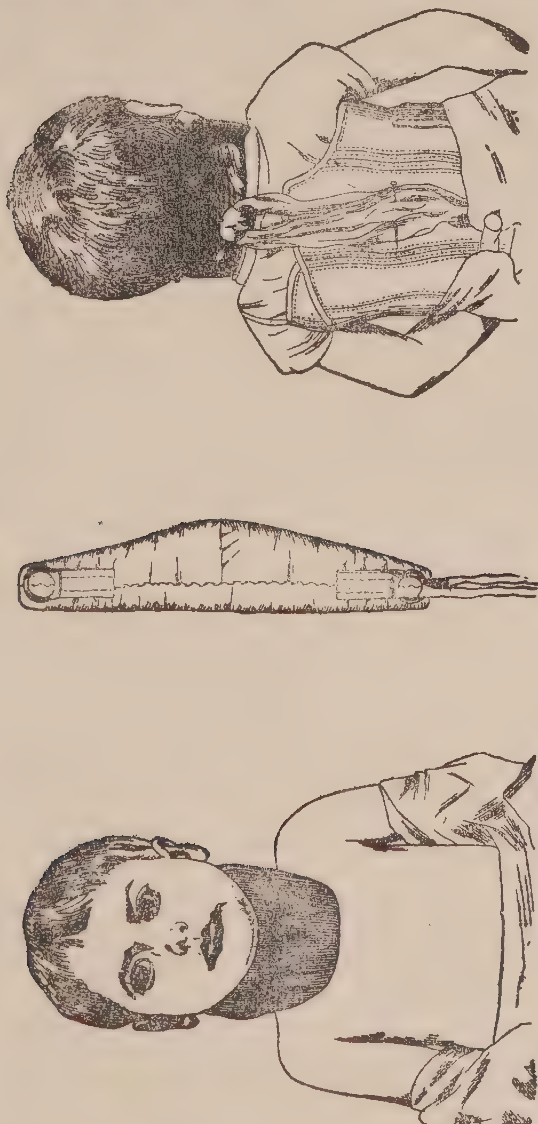
Fig. 178.

required, but with ordinary handiness the necessary bending will be easily carried out. The splint is next to be padded by wrapping domet bandage round it, for hospital patients, or more elaborate padding material for private patients. (This padding is not shown in the drawing.) Pieces of bandage are fastened to it as follows :—One at either end of the head-piece, and one at each of the four corners of the body-piece. When the splint is applied it is fixed to the head by the bandages from the head-piece, while the other bandage ends tie obliquely across the chest—*i.e.*, from one shoulder to cross the front of the chest to the opposite waist end of bandage, and the same on the other side. A jacket or bodice is worn over the splint and helps to keep it firm. It is removed at night.

(2) By a piece of poroplastic felt, cut as in the diagram (Fig. 178). The part *a* is moulded round the back of the occiput, the parts *b b* are shaped to come over the shoulders, and the part *c* lies against the back. The felt is padded and fastened with a bandage. This splint, however, is cumbrous and hot.

(3) By a high collar or stock of leather or poroplastic felt. This, however, is apt to press against the tender enlarged glands.

Failing a complete fixation of the spinal column and head by one of the foregoing appliances the surgeon may fall back on one of the following supports for the neck itself. They help considerably,



179. 180. 181.

Figs. 179, 180, and 181.—Thomas's Neck Collar (*after Thomas*).

although they may not give as much support as may be desired in some cases.

(*e*) *Thomas Neck Collar.*—This is "made by using sheet tin as a base wrapped in boiler felt and covered with leather, as shown in Figs. 179, 180, 181." These are copied from Thomas's figures, but

the rings in Fig. 180 seem too near the ends of the collar, at least when compared with his other illustration of the collar in place.

(*f*) Davy uses "plain cylindrical collars, much like swimming collars. In country practice, a dry piece of inflated gut answers very well, but in towns india-rubber is best, and is easily covered with fur, so as to imitate a victorine" (*British Medical Journal,* July 4, 1885), while Pughe has found very serviceable for poor patients "a collar made of soft leather filled with sawdust." Horsehair would be lighter and more elastic. One of the Dresden surgeons recommends a simple, but efficient, support made of alternate layers of unbleached cotton wool and firmly applied domet bandage. The cotton wool thus reinforced adapts itself to the head, neck, and shoulders, and affords the necessary support along with fixation.

CHAPTER XXIII.

JOINT-FIXATION AND FIXED APPARATUS—*Continued.*

Contents.—C. Treatment of Joints after Excision—(1) The Hip-joint — (2) Knee-joint—(3) Ankle-joint — (4) Shoulder-joint — (5) Elbow-joint—(6) Wrist-joint. **D. Various Forms of Fixed Apparatus**—Applications and Uses of Plaster of Paris—Various Splints (Watson's, The Bavarian, Croft's, &c., &c.)—Various Bandages (Starch, Water-glass, Paraffin, &c., &c.)—How to finish the Surface of Fixed Bandages.

C. Treatment of Joints after Excision.

After excision joints require to be fixed in different ways, according to whether (in the lower limb) anchylosis or (in the upper limb) mobility is desired as a final result. Thus, while rigidity is essential for an excised knee or ankle, mobility is as important for an excised elbow or wrist. In the shoulder mobility, and in the hip rigidity, is less important. It is well to remember, however, that in any case for the first fortnight, the surgeon's chief care will be to secure the kindly healing of the operation wound, by ensuring for it rest and a-septicity.

(1) *After Excision of the Hip*, light extension is applied to the thigh, and the limb is kept in position by various means. Some surgeons keep the patient at rest by the use of a single long splint on the sound side. Others use a bracketted long splint on the affected side. Others use a Hamilton's double long splint, bracketted on the affected side or with other modifications. One of these is Bryant's splint, which is recommended by Wright, of Manchester. It admits of extension, ensures parallelism of the two limbs, and allows of easy handling of the child. Stiles' modification is specially designed to ensure abduction on the affected side (see description below). R. Jones uses a special form of double Thomas hip splint (Fig. 182). As to the after result, sometimes anchylosis results, which may be either bony or fibrous. Sometimes there is fibrous union with more or less movement. Some shortening is inevitable from loss of the head and neck, and from deficient growth. In order

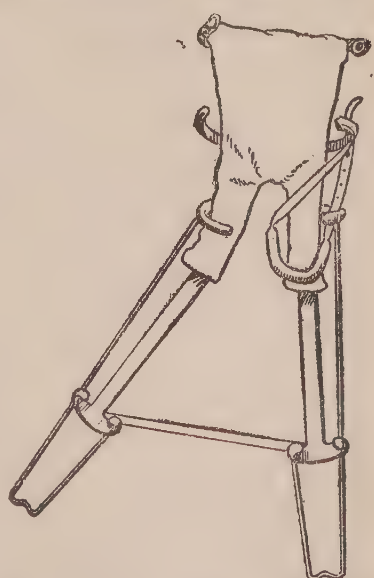


Fig. 182.—R. Jones's Abduction Splint.

to compensate for this shortening, the limb should be allowed to heal in an abducted position. Stiles aims at anchylosis in the abducted position, and plans his operation and after-treatment (including plaster of Paris fixation) accordingly. Wright aims at movement, but does not allow weight to be put on the limb till the fibrous tissue is firm. Thus he allows the child to get up in three weeks, but it must wear a Thomas hip splint for from three to six months. After that the splint is discarded, and the patten and crutches continued for other six months before weight is borne on the limb.

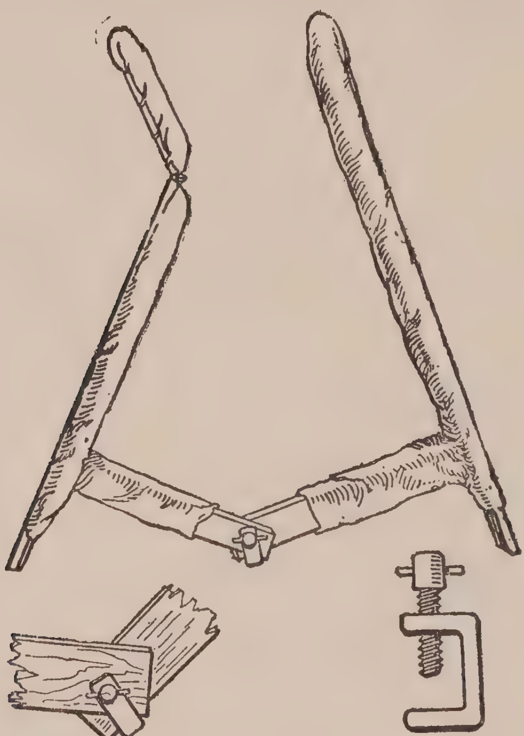


Fig. 183.—H. Stiles' Abduction Splint, showing Screw Clamp and Mode of Using it.

Stiles' abduction splint (Fig. 183) is described by himself as follows:—

"It is in reality a modification of the double long splint (box-splint) introduced many years ago by Hamilton for treating fractures of the lower extremity in children. The cross-piece, instead of being placed at the very end of the splint, as in Hamilton's, unites the two portions posteriorly a little above the heels. The splint is padded with wool covered with jaconet waterproof, Besides giving a posterior support to the legs, this position of the cross-bar is very convenient for lifting or carrying the patient while in the splint. To convert this simple splint into an abduction splint, two modifications are necessary. The first is, that the portion corresponding to the

diseased side is sawn across opposite to the hip, and the two parts united by a common hinge screwed on to the outer side of the splint; the other alteration is that the two halves of the splint are separate from each other, and each with its own cross-piece. The cross portions are made long enough for their free extremities to overlap when the affected limb is abducted to the required degree. To maintain the abduction, all that is necessary is to fix together the cross portions at the point where they overlap with a common screw clamp. The upper portions of the splint are, of course, secured to the chest by a broad binder." If abduction should be required on both sides, the second splint must also be sawn across and hinged, otherwise the arrangement is the same.

To prevent the child from twisting its body, the usual appliance for keeping the child steady should be employed—*i.e.*, a firm strap or belt is fixed to the bed behind the child, and through this are passed loops going over the shoulders and fastened to one another in front of the chest.

This abduction splint can be made from two long splints with very little trouble. The cross portions can be attached to the long splint by means of a small right-angled plate of brass or other metal pierced with holes for small screw nails. A screw clamp used for fretwork is suitable for holding the cross-pieces at the required angle. Sometimes where greater abduction is required, a separate piece of wood is employed, and is fixed to each cross-piece by a separate screw clamp.

(2) *After Excision of the Knee.*—Various splints are used by different surgeons. Some use a metal splint having troughs for the thigh and calf with a bridge between to allow room for the dressing. Others use a long wooden splint on the outside of the thigh and calf, with a posterior shelf projecting inwards behind. One of the simplest appliances is the box-splint, as made for fractures of both bones of the leg (see p. 177). The towel which surrounds the splints is sterilised. The dressings applied to the wound should be ample, as there is often considerable oozing for the first twenty-four hours. After these have been fixed in position, the limb is laid in the splint, but, owing to the dressing behind the knee, considerable padding will be required to ensure an even bed within the splint for the limb. Thus there must be padding of sterilised wool or wood-wool wadding under the thigh, and still more under the calf and ankle, as well as lateral padding of the same material. After the padding has been adjusted, the splint is fixed in position with loops or a bandage. In ten to fourteen days, when the wound has healed or nearly so, the limb is immobilised in a plaster of Paris splint, with or without a window for dressing, and is kept in it for from six to eight weeks. After this the patient may be allowed to go about on crutches with a light plaster of Paris or protoplastic splint, until bony anchylosis in the straight position is complete.

(3) *After Excision of the Ankle*, some form of interrupted splint must be employed (see Figs. 155, 156). A Macintyre splint may also be used with advantage (Fig. 115).

(4) *After Excision of the Shoulder*, no splint is required, the arm being bandaged to the side with the hand laid across the opposite breast.

(5) *After Excision of the Elbow*, it is usual to lay the arm on a pillow, and to steady it midway between pronation and supination. Some advocate a form of interrupted splint, while others put on a light extension. Passive movements should be omitted for from ten to fourteen days, or more, after the operation, and should then be slow and gentle—one such movement being sufficient at each dressing. Any movement which excites inflammation or causes bleeding will increase the danger of after-stiffness. Later on Professor Chiene advocates drawing up the arm to the head during the day, by causing the patient to wear an elastic bandage, while at night extension with weight and pulley gradually draws it down again.

(6) *After Excision of the Wrist*, the hand and fore-arm should be laid on a splint with a prominent pad under the palm; for the first two or three days the fingers may be confined, but after that they and the thumb should be left free, while the hand and fore-arm are steadied on the splint.

D. Various Forms of Fixed Apparatus.

In the sections on Joint-fixation, we have described Sayre's plaster jacket, F. Jordan's laminated plaster method applicable to the spine and elsewhere and the methods of cutting and applying pasteboard or poroplastic splints to the elbow, knee, and ankle. There are, however, additional methods and forms of apparatus, thus:—

(1) Plaster of Paris may be used as for the spinal jackets.

(*a*.) *General Application.*—After cleansing the skin and applying a layer of absorbent cotton-wool, or a bandage of flannel or boracic lint, the part must be wrapped with the open gauze bandage charged with plaster, and soaked in water just before use; eight or nine plies are needed for an adult, five or six for a child; or successive layers of ordinary bandage and plaster-cream may be laid on thus:—After a layer of bandage, a layer of plaster is smeared on, and so on till a thickness of $\frac{1}{2}$ to $\frac{3}{4}$ in. is attained; or layers of jute or absorbent wool may be soaked in the freshly-made plaster, and applied to the part, or be used to strengthen the weak places of any plaster splint.

The simplest way to remove these plaster splints is with Gigli's wire saw. A piece of stout string is laid along the bandaged limb before the plaster is applied. When the splint is finished, the ends of the string are drawn backwards and forwards to ensure its being loose. They are then made secure. When the splint has to be removed, the loop of a wire saw is fastened to one of the ends of the string and drawn through, and made to cut from within outwards by a see-saw movement. The position of the string must be regulated so that it does not pass over any convexity on the limb, otherwise the skin will be injured by the saw. The bandage must otherwise be cut with pliers or saw, or the plaster must be softened by pouring

a few drops of hydrochloric acid upon it, when it may be cut with a knife. To obviate the difficulty in removal, several methods have been advocated in which the part along the front of the limb is left free of plaster. Neudörfer's plan is one of the simplest. Compresses of linen or of lint (we may add of tow, jute, or wool) are dipped in plaster of Paris of the consistence of cream. These are then placed longitudinally on the limb, first on the upper, then on the under part. A few turns of a bandage keep them *in situ* till the plaster is set; to prevent contiguous edges adhering, they are slightly greased, or a slip of greased lint is placed between them.

If the pieces were made lateral, with an interval on the front and back, the splint when set would thus be in two halves, and could be removed by merely cutting the binding bandage along the front.

Instead of mixing the plaster with water *before* it is incorporated with the lint or tow, dry plaster may be first worked into folds of lint, layers of gauze, absorbent wool, jute, or tow (see F. Jordan's laminated plaster splint, p. 254) of the required size. These are then to be soaked in water, gently squeezed, and, having been laid on to the part, are to be bandaged into the shape of the limb.

(*b.*) *A very simple plaster bandage for the leg and foot* may be made as follows:—Make two equal laminated plaster strips of nine layers of gauze each. *Length*, from dorsum of foot under the sole and up opposite side of leg to above or below knee as required; *breadth*, half circumference at ankle, after allowing for padding. See that the limb is steadily held in the required position by assistants. Now wrap it evenly in absorbent wool, boracic lint, or flannel. Next soak one of the two laminated pieces, and apply it down one side of the leg, under the sole and round to the dorsum. The assistants who maintain the leg in position can keep this piece in its place while the other is applied in like manner. In order to facilitate after removal, the parts *on the dorsum* which overlap should be separated by a few folds of paper (the overlapping on the sole is an advantage).

A roller-bandage is now to be applied over the whole while it is still soft. When the plaster has set (ten minutes) the assistants may let go; next day when it is dry, the splint will be perfectly firm. In the interval no unnecessary strain should be put upon it.

When a window has to be left for dressing a wound, the separate pieces in many of the above methods can be easily ranged round it; but when plaster bandages are wrapped continuously round a limb, the site of the window must be indicated by placing over the wound a ball of wool, on which the plaster is afterwards cut out.

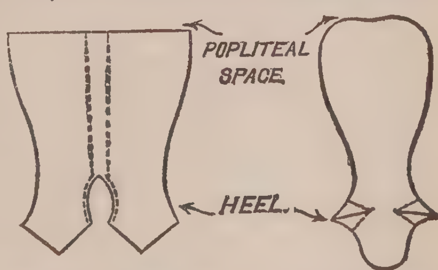


Fig. 184.—*a.* Pattern for Bavarian Splint. *b.*—Kingman's Splint (*after Gamgee*).

(*c.*) *The Bavarian Splint* is made of a double layer of strong flannel, stitched along the back, and shaped as in the diagram

(Fig. 184, *a*). The leg being held in position, the flannel is applied with the stitch behind. The inner layer is brought over and pinned in front, while the outer layer lies back. Plaster of Paris is next mixed, and spread over the outer surface of the inner layer to the thickness of about half an inch; the outer layer is then brought over, and a firm roller-bandage is applied.

(*d.*) *Croft's Splint.*—A *double* pattern from each side of the leg and foot is cut from washing flannel.* Beginning with one half of the splint, one piece of it is taken, and that face which is to lie next the leg is laid on any convenient flat surface. Plaster of Paris is then mixed, and the other piece is soaked in it, while plaster of Paris is also spread on the upper or outer face of the first piece. The soaked piece is then laid over the plastered face of the first piece. A similar procedure is meanwhile being executed by assistants with the other half of the splint. The two halves are then laid against the limb, and bandaged into position. The plan, however, afterwards adopted at St. Thomas' Hospital is to protect the leg and foot with an evenly applied flannel bandage, and then to apply a piece of coarse flannel shaped like the Kingman splint, and soaked in freshly made plaster. It is bandaged on in the same way. It may be strengthened with bar iron bent to the shape of the leg and foot, or with extra pieces of flannel, as required.

(*e.*) *Kingman's Posterior Laminated Splint* (described by Gamgee).—The shape of the layers of gauze is obtained thus—"The leg being bared, a piece of the gauze is placed beneath it, long enough to reach from the knee to a point about 10 inches below the heel, and wide enough to encircle the calf. Upon this gauze, mark out with a lead pencil a pattern similar to the outline of the accompanying sketch (Fig. 184, *b*) of such size that it shall cover the posterior two-thirds of the limb. Place the pattern upon six or eight layers of the same material, and with a pair of shears cut them together."

He lays these layers on one another, with freshly-mixed plaster between (the plan with the dry powder, afterwards wet, would seem better), and then places the soft mass beneath the limb previously padded, and after folding it up applies a roller-bandage. This splint is open in front. Flannel or carpet felt, soaked in plaster, of the desired shape, would probably do as well.

(*f.*) **Pasteboard or Poroplastic Splints.**—These, besides being shaped to the sides of the limbs, may be applied from the back, making a trough opposite any bend in the limb. The material must be incised at right angles to its long axis. When the splint is then moulded into position, there is an over-riding at the place of the cut, which gives greater strength than if the piece had been cut out (see also pp. 238 and 239).

(*g.*) **Starch Bandage.**—This is seldom applied by itself. More generally it is used over a pasteboard (or poroplastic) splint, which gives it greater rigidity, especially as the starch takes about twelve hours to dry.

* Loose open felt, such as is sometimes placed beneath carpets, is the best material for this purpose.

There are required—household starch, a bowl and spoon, kettle of boiling water, some cold water, roller-bandages, and pasteboard.

First wrap the limb in lint, wool, or flannel, then soften the pasteboard splints, and mould them into place with the fingers. Make the starch by first thoroughly breaking it down into a thick paste with cold water in the bowl. In this stage it will be white. Pour in now boiling water, and stir well. The starch will swell up and turn of a bluish tint. Add more water till the whole, being thus changed, pours easily out of the spoon. As it cools it will set into a jelly, but it may be used in either the liquid or the jelly state. Powdered boracic acid, about 10 per cent., may be added along with the boiling water with advantage.

A layer of roller bandage having been now firmly applied over the pasteboard splint, is then smeared over with starch. A second layer of bandage is in turn smeared over, and so on for three or four layers. To dry the starch, lay the limb near the fire, or place hot bottles alongside of it.

(*h.*) **Water-glass Bandage.**—This is a silicate of soda, dissolved in excess of caustic alkali (according to Wagstaffe, silicate of potash is not so good). It may be used instead of starch, and dries more quickly, although it does not harden completely for two or three days. It is light, strong, and cheap (4d. to 6d. per lb.). It may be ordered from most wholesale druggists.

Water-glass may be used with or without pasteboard. When extra hardness is needed, whiting, powdered chalk, slaked lime, or magnesia should be mixed with it to the consistence of batter. As in the starch bandage, after a layer of roller-bandage, the water-glass alone or mixed with whiting should be smeared on with a brush or sponge, then another layer of bandage, and so on for three or four layers. (Esmarch advises the use of a freshly-made concentrated solution of neutral silicate of potash.) By moistening the water-glass, it may be softened previous to cutting it for removal.

(*i.*) **Gum and Chalk.**—A mixture of mucilage and powdered chalk of the consistence of paste may be used instead of starch or water-glass; but it has no advantage over these, and is dearer.

(*k.*) **Paraffin Bandage.**—Paraffin may be applied with a brush in the melted state in the same way as starch. Although not so rigid as water-glass, it has the advantage of being waterproof; and though more expensive than most of the above, it may be boiled out of old bandages, and used over again.

(*l.*) **Finishing the Surface of Fixed Bandages.**—Plaster of Paris may be glazed with switched white of egg or with size. Its surface may be rendered waterproof by a layer of paraffin, or by several layers of boiled linseed oil, damar, or shellac varnish. In a similar way, a waterproof coat may be applied to any of the other fixed bandages, and is especially needed for children.

In the neighbourhood of a window cut for dressing a wound, Esmarch advises a packing of wool saturated with collodion to prevent the soaking in of discharge. In the absence of collodion, some of the other waterproof materials above mentioned might be substituted.

CHAPTER XXIV.

THE URINE.

Contents.—Importance of a Knowledge of the State of the Urine in Surgical Cases—**A. General Conditions to be Noted**—Quantity of Urine, Pain associated with Micturition, Odour, Colour, Transparency, Reactions, and Specific Gravity of Urine. **B Occurrence of Abnormal Substances in Urine**—Albumin; Bile; Sugar; Blood; Pus—Urinary Deposits. **C. Examination of the Urine**—Preliminary—For Abnormal Substances in Solution—For Deposits—Collection of Urine from each Kidney.

Importance of a Knowledge of the State of the Urine in Surgical Cases.—Although the investigation of the Urine is more usually considered as forming a part of the duty of the *Physician*, yet there can be no doubt whatever that a careful examination of this excretion, and a due appreciation of its various abnormalities, is of the utmost importance to the *Surgeon*. Apart from the necessity of studying the urine in "surgical" affections of the genito-urinary tract, there are many cases where the state of the kidneys or other organs as indicated by the urine may determine the advisability or not of an operation, and may very materially affect its prognosis, if it be undertaken. As a report of the urine is a necessary complement to most surgical "cases," a chapter devoted to the investigation of the urine from an especially surgical point of view seems to be called for in the present work.

A. General Conditions to be Noted.

The general questions involved in the examination of the urine will be briefly discussed before the methods of investigation are given in detail.

(1) **Quantity of Urine.**—This is estimated by collecting and measuring the urine passed in twenty-four hours, and is important—(*a.*) because deviations merely from the normal quantity often indicate disease; (*b.*) because, without a knowledge of the quantity, no reliable conclusions can be drawn from a knowledge of the specific gravity.

The normal amount of urine for an adult varies from about 35 to about 65 ounces in twenty-four hours—on an average, about 50 ounces. The quantity will vary with that of the fluid drunk and with the extent of its excretion by the skin, lungs, and bowels. These factors must be taken into account before any conclusions as to abnormality can be arrived at, although, of course, an insatiable thirst and appetite are themselves symptoms of Diabetes Mellitus.

Variations in the Normal Excretion.—An important matter is the varying rate at which urine is excreted during the twenty-four hours by the kidneys.

Roberts has shown* that the solid and fluid constituents of urine are much increased after meals, and diminished during fasting and sleep. From this two deductions may be drawn, which might be of service in surgical cases—(1) That the urine, like the fæces, may be reduced by a sparing solid as well as liquid diet, in cases where it might be thought necessary; and (2) that where urine had to be repeatedly drawn off by the catheter, the meal-hours might be so planned to suit the surgeon's time, that his visits an hour or so later would relieve the bladder after the increased flow had occurred.

Urine is **diminished** in feverish conditions, especially those associated with sweating; in cirrhosis of the liver; in heart-disease, when it results in backward venous congestion, or lowered arterial blood-pressure; in acute Bright's disease, or in the acute interstitial nephritis reflexly caused by irritation to the urethra, or in the later stages of all forms of chronic Bright's disease; in rapid removal of fluid from the blood, as in severe hæmorrhage, extensive serous effusions, persistent vomiting, or violent diarrhœa; in peritonitis, and in severe irritation of the splanchnic nerves, as in strangulation of the bowel, and in renal or hepatic colic; also in blockage of the ureter by a calculus or by the pressure of a tumour.

Complete Suppression of Urine—A condition of the utmost danger—may occur not only in severe forms of Bright's disease, and in the course of any violent fever, but also in the congestions and inflammations of the kidneys which are apt to follow even the simplest operations on the urethra or bladder, especially when there has been long-standing backward pressure in the pelvis of the kidney from obstruction to the outflow of urine, due to stricture or enlarged prostate. Suppression may also be caused by an overdose of turpentine, nitric acid, or other irritant, or by the absorption of cantharides from a large blister.

An **increased** quantity of urine may be due to diabetes insipidus or mellitus; to the early stage of any degeneration of the kidneys, of which it is sometimes the first symptom, and to waxy disease in particular; to the intermediate stage of cirrhotic kidney associated with increased arterial tension; to irritation in the prostate acting reflexly as in an early stage of tubercular deposit or senile enlargement; in certain degrees of backward pressure, as in the partial or intermittent obstruction of the ureters which leads to hydro-nephrosis; or to cystic degeneration of the kidney. It is also caused by nervous excitement, and is often a symptom of hysteria.

The **frequency** of micturition should always be noted, as, taken along with other symptoms, it is an important detail in diagnosis.

Like the quantity of urine, the frequency of micturition may be

* *On Urinary and Renal Diseases.*

relative, but when there is an increase from the patient's previous habit, or when the frequency is manifestly above the normal, some cause must be looked for.

The increase in frequency may be attributed solely to a larger quantity of fluid passed, but besides, its explanation may be sought

(1) In the irritating quality of the urine, when highly concentrated, charged with acid, or loaded with sugar.

(2) In irritations of the genital organs and perinæum, as in congenital phymosis and adherent prepuce, and occasionally in gonorrhœa and piles. In children, and occasionally in adults, from worms in the rectum.

(3) In obstruction to the outflow of urine, as in stricture of the urethra and enlargement of the prostate (mostly at night).

(4) In irritation of the bladder from cystitis, presence of a calculus or foreign body, tumour or tubercular deposit in the bladder-wall, or cellulitis near the bladder. Also in pressure against the bladder-wall from tumours, misplaced uterus, or pelvic accumulation of fluid—*i.e.*, pus or blood.

(5) Irritation of the kidney, as in renal calculus, or tubercular pyelitis.

N.B.—The most sensitive parts of the urinary tract seem to be the prostatic portion of the urethra, the floor of the bladder in and near the trigone, and the pelvis of the kidney, a gradual deposit of tubercular matter, a quietly growing tumour, or a slowly forming calculus, may for a time escape notice, especially when they affect the less sensitive parts of the urinary tract.

(2) Any **Association of Pain with Micturition** should also be observed and recorded. Pain *before* micturition indicates sensitiveness to stretching of the bladder-wall, generally from cystitis, but sometimes from an ulcer, or new growth; also from pressure on the vesiculæ seminales when they are distended and inflamed; *during* micturition, some obstruction to the flow, as stricture, also irritating quality of the urine, a highly sensitive urethra as in urethritis, or a caruncle in women; *after* micturition, generally some irritation at the neck of the bladder as from a calculus or tubercular deposit there, or from an inflamed prostate.

Almost all irritations of the neck of the bladder and in the urethra cause referred pains at the point of the penis, or at the orifice of the urethra in women, and those in the kidney and ureter often cause similar pains shooting down to the testicle and scrotum in men, and towards the groin in women.

Occasionally penile pain has been caused by irritation in the kidney; pain in the perinæum is chiefly due to affections of the prostate and vesiculæ seminales, while pains in the loins and thighs are felt in various conditions, and may be reflex or due to direct involvement of nerves when an inflammation or new growth has extended beyond its original seat in the urinary tract.

(3) The **Odour of Urine** is peculiar to itself; familiarity with it is necessary for the detection of abnormalities, and for diagnostic purposes, as it is often important to know whether certain

doubtful fluids contain urine or not. Urine alkaline from decomposition smells of ammonia, while, when alkaline from fixed alkali, "it has a sweetish aromatic odour like that of the fresh urine of the horse or ox" (*Roberts*). Blood or bloody discharges, when decomposing, give it a stale offensive odour; turpentine, one like that of sweet violets; while copaiba, cubebs, and sandalwood oil, communicate their own peculiar odour which is easily recognised.

(4) The Colour of Healthy Urine varies from a pale straw tint to a full amber-yellow in different individuals, and is generally darker in the morning than at other times; the colour is *deepened* when the total quantity of urine is diminished while the solids are unchanged or increased, as in feverish or rapidly-wasting conditions, after muscular exercise or severe sweating. *Pale* urine occurs when the fluid part of the urine is relatively increased, as after much fluid has been drunk; following a hysterical paroxysm; also in diabetes and chronic forms of Bright's disease.

A pinkish-red pigment is found in the urine of patients when feverish, and when suffering from severe organic disease—especially of the liver; it has a strong affinity for uric acid and urates, and gives them their familiar brick-red colour. A black pigment—melanin—sometimes only a chromogen, or pigment-forming substance, accompanies sometimes melanotic tumours. Indican, also chiefly a chromogen, when in excessive amount darkens the urine. Such excess is found in such conditions as obstruction of bowels, diarrhœa, peritonitis, and cancer of abdominal viscera.

Blood Pigment, when first added to urine, colours it *red.* Should the reaction be acid, the hæmoglobin is soon split up and the acid hæmatin gives a dark or *smoky tint* to the urine; in a urine alkaline from fixed alkali the colour is said to be unchanged. In ammoniacal decomposition of urine it is soon changed with the formation of alkaline hæmatin.

Bile Pigments in the blood are excreted by the kidney, and give a *dark yellowish or greenish hue* to the urine, which froths easily and shows a corresponding tint on the bubbles.

As bile pigments can be detected in the urine both before and after any recognisable changes in the colour of the skin, their presence may be of great service in detecting or tracing obstructive jaundice, as from gall stones or pressure on the bile ducts.

Certain Drugs and Dyes, when taken into the system, colour the urine; thus carbolic acid, salol, sulpho-carbolate of soda, creasote, resorcin, or naphthalin, produce an olive green or brown colour; santonin, or chrysophanic acid, yellowish-brown; sulphonal, dark red; antipyrin, clear blood-red; beetroot and prickly pear, red; methyl blue, blue; logwood, reddish, &c.

(5) Urine is normally quite transparent. In an acid urine, an *opacity* which only appears after cooling will be due to excess of urates, while an opacity seen at first may be due to oil-globules, as

in chylous urine or fatty embolus, to the effect of copaiba or cubebs taken internally, to excessive mucus, or, most frequently, to pus.

In an alkaline urine, turbidity may be caused by earthy phosphates, but it generally indicates decomposition. A ropy deposit of altered pus and mucus, and an ammoniacal smell will be present in the latter case.

(6) The **Reaction of Urine** in health is generally acid, due to acid phosphates and urates.

After food has been absorbed, the reaction becomes more or less alkaline as it leaves the kidney, although after mingling with the acid urine in the bladder, it may never be actually alkaline when passed from the urethra. The secondary effect of a meal, especially of animal food, is to increase the acidity of the urine. It has been pointed out that the acidity of the urine varies inversely with the secretion of the gastric juice. When there is much acid in the stomach, a less quantity is excreted by the kidneys, and *vice versâ.*

Urine may be *permanently alkaline* (1) in patients when in an anæmic and depressed state. (2) From the internal use of alkalies (caustic and carbonated) and alkaline salts of acetic, tartaric, citric, malic, and lactic acids. (3) From ammoniacal decomposition where, through the agency of micro-organisms, urea unites with water to form carbonate of ammonia.

The reaction of urine often throws great light upon clinical symptoms.

An *unduly acid* condition seems chiefly to excite the mucous membrane of the urinary tract, and over-stimulate its nervous and muscular activity; producing symptoms very like those of calculus in the kidney or bladder. In some cases it may be the cause of small quantities of blood and pus in the urine, which still further complicates the diagnosis. An *alkaline condition* from any of the above causes except the last (decomposition) seems to have no effect on the urinary passages, and is not liable to form any calculus. On the other hand, urine alkaline from *ammoniacal decomposition* is a strong irritant of the mucous lining of the whole urinary tract, sooner or later inflames it, and tends to deposit phosphatic salts. An important relation has been traced by Lister between the state of the mucous membrane and the action of micro-organisms. If the former be healthy, the urine seems able to withstand the action of micro-organisms even when implanted within the bladder; but if it be already irritated or inflamed, the fermentative process is easily started, and, once begun, it still further destroys the resisting power of the mucous lining, and decomposition goes on unchecked.

In most cases, contamination of urine by micro-organisms is produced by the use of dirty catheters, the risk of contamination being greatest in those cases where instrumentation is most required—*i.e.*, in stricture, prostatic enlargement or paralysed bladder, or when a calculus is present. Besides the irritating effect of decomposing urine, the tendency to deposit ammonio-magnesium phosphate adds greatly to the patient's danger; a previously existing calculus will be

increased, or a new one formed, or the lining membrane of the bladder be encrusted with phosphates. Although uric acid calculi are slightly soluble in urine rendered artificially alkaline, no method of dissolving phosphatic calculi has yet been discovered, either by injections into the bladder, or by the administration of drugs, hence a phosphatic coating stops any attempt at removing a calculus by other than surgical means (*Roberts*).

An unduly acid state of the urine may be caused by (1) constitutional causes. This is clinically important as indicating a liability to the formation of a calculus in the urinary passages, or as causing symptoms like those due to a calculus. (2) Muscular exercise.

The **Specific Gravity** of the urine, taken along with the total quantity passed, is a direct indication of the activity of the kidney-substance and of the quantity of solids excreted. Necessarily, it will vary with the amount of fluid drunk, and of that removed by the skin and bowels.

As the relative and absolute amount of solids excreted varies from time to time according to meals, fasting, and exercise, an average can only be arrived at by mixing together the whole urine passed during twenty-four hours. The average specific gravity has been found to be about 1,020, taking water as 1,000; variations, however, from 1,006 to 1,030 are not uncommon.

Apart from varying quantities of fluid drunk or excreted by other channels, a *high specific gravity*, with a pale urine, points to diabetes mellitus with sugar in solution, with a dark urine to feverish conditions with excess of urea in solution; while a *low specific gravity*, with a pale urine, leads to a suspicion of chronic kidney disease, and possibly albumin. Even where no albumin can be detected, a persistently low specific gravity should always make a surgeon anxious.

The **kidneys** in such cases are not doing their work properly, and hence not only impair the patient's general health, but are apt to fail should an operation involve a strain upon their functions, and to break out into active disease on slight provocation. As the kidneys may be considered one of the chief means of purifying the blood, any septic condition is apt to throw a severe strain on their functions. Indeed, in such cases, micro-organisms and their products have been seen when looked for in the urine, and large quantities of micro-organisms have been found *post mortem* in the kidneys. Hence the special importance of healthy kidneys in septic wounds, as well as in operations on the genito-urinary tract.

When pressure within the ureter is increased, the excretion of solids is lessened before the current of fluid is affected—hence a *lowered specific* gravity may sometimes point to an *obstructed ureter*.

B. Occurrence of Substances not found in Healthy Urine.

(1) **Albumin** is to be detected by some of the methods to be afterwards described.

Although traces are occasionally found in the urine of healthy persons the presence of albumin is always to be looked on with suspicion, and demands an investigation into its cause. The harmless forms of albuminous urine have been classified as those due to diet, excessive exercise, or special paroxysms (*Stewart*).

Other causes are various—(*a*) Chronic renal disease. If the urine be pale, of low specific gravity, and normal or deficient in amount—especially, also, if there be a deposit of tube-casts—chronic renal disease must be suspected and reckoned upon.

(*b*) Acute renal inflammation. A scanty, high-coloured urine, with a considerable quantity of albumin—especially if there be also a deposit of blood-corpuscles and tube-casts, as well as general fever and pain in the loins—will point to acute inflammation of the kidney. This condition may come on in the course of a case which is under surgical treatment. It may be found in any form of acute blood-poisoning, such as diphtheria, erysipelas, septicæmia, or pyæmia.

(*c*) Congestion of renal veins from mechanical obstruction.

(*d*) Pus, blood, or serum, poured into the urinary tract from any cause. Even after blood-corpuscles have ceased to leave the vessels, the presence of albumin in the urine may show that serum still escapes. It is often very difficult to calculate how far the albumin in any urine is due to the pus and blood mixed with it, and how far to diseased kidneys.

(*e*) To leucorrhœal discharges, or the menstrual flow, which may be followed by albumin in the urine for some days after every other recognisable trace of blood has disappeared.

(2) **Bile** in the urine may be due to obstruction to some of the bile-ducts within, or outside of, the liver. It may be suspected in a greenish-brown coloured urine, with a tinted lasting froth.

To distinguish between bile-pigments and those caused by rhubarb or santonin, an alkali may be added, when the former will be changed to a dirty brown, and the latter become a deeper red.

It is well to remember that, although the presence of bile in the urine may point to temporary or permanent obstruction of the hepatic or common bile-ducts by gall-stones or otherwise, the absence of bile by no means excludes a blocking of the cystic duct, a filling-up of the gall-bladder with gall-stones, a former temporary obstruction of the other ducts, or even the permanent lodging of a gall-stone in the common bile-duct, because the gall-stone may act as a ball-valve and only cause obstruction occasionally. In all cases of doubt, the test for bile-pigments to be afterwards given must be applied.

(3) **Sugar** in the urine may be temporarily present in small quantities, or be found there as a constant ingredient. In the latter case, it indicates diabetes mellitus, which sometimes has important surgical aspects.

In some cases an intractable eczema is caused by it on the parts near the meatus urinarius (in both sexes); in other cases it is associated with numerous boils or carbuncles, and sometimes with gangrene. More recently sugar in urine has been found temporarily present in many acute inflammations, and may be considered an indication of commencing suppuration, so as to help in the diagnosis of obscure cases. Temporary glycosuria has often been observed after inhalation of chloroform, and is of no importance.

(4) Blood in the urine—hæmaturia—often of the greatest importance in surgical diagnosis, may be due to lesions of, or inflammation at, any part of the urinary tract, from the kidney to the orifice of the urethra. When blood gets immediate access to the urethra, it may be passed independently of any urine, or be mingled with the first few ounces of it only, the rest being clear. Such a relation would be seen in a *partial* rupture of the urethra (if complete, there would be no subsequent flow of urine); in rupture of the vas deferens through muscular strain (*Hilton*); or in the course of severe gonorrhœa. Vesical hæmorrhage is mostly seen at the end of micturition; while in renal hæmorrhage the blood, unless in very large quantity, is uniformly mixed with the urine and darkened in colour.

From the colour, an idea may be gained as to the source of the blood; because the longer it has been mingled with the urine, the more will it be changed, and *vice versâ*. Bright-coloured blood in an acid urine must, therefore, have come from the urethra, or from the bladder or kidneys just before it was passed; while darkened blood pigment will have been shed from the kidneys or ureters, or from the bladder some time before being passed. Clots from the ureter, urethra, or pelvis of the kidney, when floated out in a basin of clean water (*Hilton*), will resemble casts of those parts, or of calculi which caused the bleeding (in the latter case particles from the calculus may adhere to the clot), while from the bladder they will be irregular. Blood in minutest quantity can be detected with the microscope by its corpuscles, when no change in the colour of the urine can be traced.

Following an injury to the *loin*, or a strain, hæmaturia may indicate one or other of the following renal conditions (*Morris*):—

(*a.*) Contusion of the kidney.

(*b.*) Congestion of the kidney, similar to that produced by turpentine or cantharides, following the injury, or owing to the displacement of a previously encysted calculus.

(*c.*) Congestion due to an embolus, or thrombus, the result or accompaniment of the injury.

(*d.*) Kidney uninjured at first, but secondary inflammation spreading to it from surrounding damaged tissues; here hæmaturia appears late.

(*e.*) Shaking of the kidney. This may cause hæmaturia in some persons without, but generally indicates, a renal calculus.

Other sources of renal hæmorrhage are calculi, new growths, tuberculous or putrefactive pyelitis. In addition, hæmaturia, apart

from an injury or from an embolus, may be expected in acute nephritis of whatever kind; in the course of chronic nephritis, from direct or indirect effect of a calculus, or from excess of uric or oxalic acid in the blood.

When the source of bleeding is the *bladder*, a calculus, a simple or malignant tumour, cystitis, tuberculous ulceration, or (after a severe injury) a rupture may be traced as its cause.

Bleeding often comes from dilated veins about the prostate in old men, and as the blood may easily pass back into the bladder, the diagnosis may be difficult. Hæmaturia and serious lesions of the urinary tract are sometimes traced to a parasite (bilharzia hæmatobia), and bleeding occasionally follows the sudden evacuation of an over-distended bladder.

From the *urethra*, besides the causes of bleeding already noticed, a new growth, urethral calculus, or chancre, may be accountable.

In women the menstrual flow or blood from a tumour at or near the cervix, escaping by the vagina, may contaminate the urine and simulate hæmaturia.

(5) **Pus** in the urine—pyuria—like blood, may have its source in any part of the urinary tract.

When pus is detected, its source should be ascertained, if possible. That from the urethra will be swept out with the first few ounces of urine, which should therefore be collected separately. If the remainder of the urine comes away clear, the diagnosis is pretty certain, but if not, an effort may be made to distinguish between pus from the kidney and that from the bladder. By first washing out the bladder and then tying in a catheter, a sufficient sample may be obtained. If it be uniformly turbid, the source of pus will be above the bladder; if clear, probably in that viscus (*Thompson*). When the urethra has been localised as the source of the pus, we may require to know whether the pus comes from the anterior or posterior urethra (in front of or behind the compressor urethra), and if from the latter, whether from the mucous membrane or from a collection opening on to it. The following method may then be adopted:—The patient having retained his water for some time, the surgeon passes a small sized soft catheter down to, but not beyond, the triangular ligament, and through this washes out the anterior part of the urethra with sterilised water, boric lotion, or $\frac{1}{18}$ per cent. of salicylic acid. If the patient then micturates into two beakers, the first will contain the sediment which has been lodged in the posterior urethra. Should we wish, however, to know if discharge is being poured into the posterior urethra, three beakers will be needed. The anterior urethra is washed out as before, then the patient passes some water into the first beaker, the surgeon then passes his finger into the patient's rectum, and tries to press out fluid from the prostate and vesiculæ seminales, some may escape at the meatus and settle the question, but if not, the patient micturates into the second beaker which will then contain whatever the surgeon has pressed into the posterior

urethra; the remainder of the urine is now passed into the third beaker to make sure that the deposit has not come from the bladder.

Coming from the kidney, pus may indicate pyelitis (by extension of septic mischief from the bladder, from tuberculous deposit, or from the irritation of a calculus), a tumour, suppuration within the kidney, or acute nephritis.

When the bladder is its seat, it may be due to cystitis, tumours, tuberculous ulceration, a stone, or bilharzia.

From the urethra, gonorrhœa or gleet is the usual source of pus; more rarely a urethral abscess, and occasionally a tumour, urethral chancre, or secondary syphilitic ulceration. Bilharzia hæmatobia is said to lodge most frequently in the prostatic urethra.

The *cystoscope* in practised hands is often of the greatest use in ascertaining the source of pus and blood in doubtful cases. The condition of the bladder wall can be observed and the flow from the ureters watched, while the condition of the vesical orifice of the ureter often indicates that of the ureter or kidney above. In many cases it is necessary to examine the urine collected separately from each kidney, either by a urine separator (see p. 289) or by the catheter cystoscope.

The Occurrence of Urinary Deposits.—After urine has been allowed to cool and stand for several hours, a deposit is generally seen, varying from a delicate cloud of mucus in health, to distinct sediments in disease. The naked-eye and microscopic characters of these must be noted. The materials of some of the deposits are formed in the urine before it cools, while those of others only appear after cooling.

Those which appear *before*, are pus, and occasionally crystals of uric and oxalic acid, when in excess, entangled in mucus, also amorphous phosphates.

In an alkaline urine, crystals of ammonio-magnesium phosphate may be seen. Where a deposit occurs before cooling, there will be greater risk of calculus formation within the body, although, as V. Carter has shown, it is probable that calculi are not the result of aggregation of the ordinary crystalline forms of the various substances, but of the combination of a modified crystalline form with mucus in a way not as yet clearly understood.

After cooling the commonest deposit is one of amorphous urates of soda, ammonia, lime, or magnesia.

These may be seen under many conditions—such as excessive muscular exercise, congestion of the liver, any feverish condition, errors of diet, and from dyspepsia. When visible continuously for some time they indicate liver derangement, and being premonitory of gout and uric acid formation, require treatment (*Murchison*). If co-existent with piles they would call for an improvement in the hepatic circulation.

Besides urates, crystals of uric acid or oxalate of lime may be deposited, one or both, generally with urates also. Their deposit will depend partly on the quantity of acid present, partly on the acidity of the urine. In an alkaline urine, phosphate of lime in an amorphous or partly crystalline form may be seen, also crystals of

triple phosphate; in ammoniacal decomposition the triple phosphate is always present.

More or less *mucus* is always associated with any of the above deposits, and holds them together. After urine has stood for a time, a *scum* often appears on its surface. This may consist of urates, phosphate of lime, triple phosphates, micro-organisms, or of oil-globules.

The latter may be seen after severe fractures attended by crushing of the medulla, and according to some authors, to a certain extent in most fractures. Oil-globules are present in the circulation, and are excreted by the kidneys. They occasionally give rise to the severe symptoms associated with fatty embolus, in the later stages of diabetes, and in the rare and obscure disease called chylous urine.

(The observer must, of course, exclude the possibility of the oil having been introduced into the urine by the lubrication of instruments.)

C. Examination of the Urine.

Where possible, for reasons already given, the whole urine passed in the preceding twenty-four hours should be collected and measured; failing this, morning and evening urine may be mixed when the specific gravity is wanted. Urine after fasting is most acid; that after meals will have the highest specific gravity; and will reveal the smallest traces of albumin.

Where pus is present, urine from a single micturition should be collected in separate vessels.

Preliminary Examination.—After the total quantity of urine for twenty-four hours has been measured, a portion should be placed in a narrow cylindrical jar, holding about a pint, and be allowed to stand; in an hour or two afterwards the examination may be made, noting:—

1. *Colour.*
2. *Odour.*
3. *Froth*, whether permanent (*i.e.*, indicating albumin) or not, or if tinged with bile.
4. *Deposit.*
5. *Reaction.*—This is to be tested with litmus paper.

The ordinary blue colour will be changed to red if the reaction be acid; and, if previously reddened, will be turned blue again by an alkaline reaction. Where ammonia is the cause of alkalinity—as in decomposition—it may be driven off with gentle heat so as to allow the red colour to re-appear. With other forms of alkalinity, this is not possible. Violet litmus paper available for either acid or alkaline reaction is sometimes used, while instead of reddened litmus paper, yellow turmeric paper—turned brown by an alkali—is sometimes employed.

6. *Specific Gravity* is generally ascertained by means of a urinometer, or hollow glass cylinder, weighted with mercury below and having a graduated stem above. In water the stem should sink as

low as the mark 1000; the more the solid matter suspended in any fluid, the higher will the stem rise. As the fluid tends to rise up around the stem, the figures should always be read off by placing the eye on a level with the surface of the liquid in the jar. The urinometer should be entirely immersed once or twice before being read off, and should not be allowed to rest against the sides of the vessel.

Examination for Substances in Solution.—Next, we test for substances in solution.

1. For the quantity of a substance normally present—*i.e.*, urea—the hypobromite of sodium method, with the instrument known as Southall's ureometer, is the best. As directions are sent with the instruments it is unnecessary to detail them here.

2. For the presence of substances normally absent, *i.e.*—

(*a.*) **Albumin**—*i.e.*, serum albumin and globulin, which for practical purposes are the only forms whose presence is important.

(*a*) *By Boiling after Acidulation.*—"A test tube is charged with about 3 fluid drachms (10 c.c.) of urine. To this is added a single drop of acetic acid. The upper half of the column is then heated to ebullition. If albumin be present, the upper boiled portion of the column will show opalescence in contrast with the lower half, which remains unchanged. If the urine be alkaline, it should be carefully neutralised by adding successive drops of acetic acid, until the litmus paper shows a distinct, but slight, acidity, and then the final drop of acid is added before boiling. Even if the urine possesses its natural acidity, it is better to add a drop of acid, if you want to bring out the maximum sensitiveness of the boiling test. When performed with these precautions, the boiling test is the most sensitive and the most reliable of all albumin tests" (*Roberts*).

If the urine be alkaline, cautiously add dilute acetic (2 per cent.) till there is a distinct acid reaction with blue litmus paper; then proceed to boil.

If urates be present, boiling alone is sufficient, as the urates indicate acidity. Heat re-dissolves the urates, and as the boiling-point is approached a cloud of albumin will appear, if present.

If the urine be turbid after heating, it should be filtered before it is tested by boiling.

Should the urine have been alkaline, or faintly acid, when boiled, a cloud of phosphates is likely to appear. This cannot be distinguished from albumin until a few drops of nitric acid are added, when the phosphates will be dissolved, and albumin, if present, coagulated.

(β) *Nitric Acid.*—"Nitric acid is an extremely delicate test for albumin, and is the test to use first in all cases except when the urine is turbid from urates. The best manner of applying it is to fill a test tube to the depth of about an inch; then, inclining the tube, to pour in strong nitric acid in such a manner that it may trickle down along the side of the tube to the bottom, and form a stratum some quarter of an inch thick below the urine. Added in this manner, there is scarcely any mingling of the two fluids, and, if albumin be present, three strata or layers will be observed—one,

perfectly colourless, of nitric acid at the bottom; immediately above this an opalescent zone of coagulated albumin; and at the top the unaltered urine. If there be only a trace of albumin, twenty or thirty minutes elapse before the opalescent zone becomes visible."

Cautions!—"In concentrated urines, and especially in febrile urines, the addition of the acid is apt to precipitate the amorphous urates, and thus to occasion a turbidity which might be mistaken for albumin."

"Albumin begins to coagulate immediately above the stratum of acid, and the turbidity spreads upwards; but the urates first appear at or near the surface of the urine, and the opacity spreads downwards. Heat also readily resolves the doubt; for urates speedily disappear when the urine is warmed, but turbidity from albumin is not affected by heat."

Albumoses are precipitated by nitric acid, but not by heat. The clinical import of albumose is uncertain, but it sometimes alternates with albumin.

Nitric acid may increase the opalescence commonly present in the urine of patients who are taking cubebs and copaiba.

When excess of urea is present in the urine, nitric acid produces a crystalline deposit of nitrate of urea after the fluids have been some time in contact.

Too small a quantity of nitric acid will fail to coagulate the albumin; a large quantity, if *mixed* with the urine, will re-dissolve it.

(*b.*) Sugar.

N.B.—"*Before Testing for Sugar*, albumin must be removed by boiling and filtering the acid urine" (*Bedford*).

By Safranine Test, described by Bedford, as follows:—

(1) Take equal parts of—

(*a*) The albumin free urine.

(*b*) Liquor potassæ (B.P.), which must be free from lead, and not too old.

(*c*) 1-1000 solution of safranine (*i.e.*, ·35 gramme, or about 5 grains of safranine dissolved in 33 cc. of distilled water). The resulting mixture is dark blood-red and opaque.

(2) Boil this mixture in a test-tube, but avoid as much as possible *shaking up* the mixture. Then cool; if more than 1-10th per cent. of glucose be present the opaque RED colour disappears, a yellow colour taking its place.

"This test is the simplest, and, fortunately, also one of the surest tests for glucose, and is not interfered with by the presence of uric acid, hippuric acid, creatinin, nor apparently by glycuronic acid. The solutions required keep well, and are much more readily prepared than Fehling's or other reagents."

By the Reduction of Oxide of Copper (*with Fehling's Solution*).—"Pour some of the prepared test-liquor into a narrow test-tube to the depth of three-quarters of an inch; heat until it begins to boil; then add two or three drops of the suspected urine. If sugar be abundant, a thick yellowish opacity and deposit of yellow suboxide are produced, and this changes into a brick-red at once if the blue colour of the test remain dominant. If no such reaction ensue, go on adding the urine until a bulk nearly equal to the test

employed has been poured in; heat again to ebullition; and no change occurring, set aside without further boiling. If no milkiness is produced as the mixture cools, the urine may be confidently pronounced free from sugar, for no quantity above a fortieth of a grain can escape such a search, and any quantity below that is devoid of clinical significance" (*Roberts*).

Caution!—Certain drugs, such as copaiba and chloral, also glycuronic acid, which may be present in health, mucin, uric acid, and other nitrogenous matters, often present in urine, likewise reduce cupric oxide—hence, in doubtful cases, it will be necessary to employ the following:—

By Fermentation Test.—Fill two similar test-tubes two-thirds with mercury. Fill up one with the suspected urine, and the other with healthy urine. To each add a little tartaric acid and a small piece of well washed yeast, invert them over mercury, and leave in a warm place. A slight fermentation occurs in healthy urine, but it will be marked if sugar is present.

Cammidge's Reaction is useful as an aid to diagnosis in cases of suspected disease of the pancreas, whether primary or secondary to the presence of a gall-stone in the ampulla of Vater.

Principle of the Test.—In cases of pancreatitis, the urine, when hydrolysed with an acid, and treated by phenylhydrazine in the manner indicated, yields a substance in crystalline form which is believed to be a pentose. This substance is absent in normal urine, the reaction being thus negative. In cases which give a positive reaction the deposit may be small in amount or considerable.

Method.—Take 40 cc. of filtered urine and add 2 cc. hydrochloric acid and boil for ten minutes.

Cool to as low a temperature as possible in running water, and add 8 grms. lead carbonate (to neutralise excess of acid), shake well and let this stand for two or three minutes to complete reaction, then filter.

To the above filtrate add 8 grms. tribasic lead acetate, shake well and filter (to remove certain glycuronic compounds); if a cloudiness appears at this stage it will be necessary to repeat filtration until the filtrate becomes quite clear.

To this filtrate add 4 grms. of sodium sulphate and heat the mixture to boiling point, cool and filter (to remove the lead).

Take 10 cc. of the filtrate and make up to 18 cc. with distilled water; to this add 2 grms. sodium acetate, ·8 grm. phenylhydrazine hydrochloride, and 1 cc. of 50 per cent. acetic acid (glacial), boil slowly in a sand bath for ten minutes, then filter into a clean test tube, and let it stand for a few hours and examine. At this stage it is always safest to let the filtrate stand overnight, as some crystals take longer to form than others. The long delicate crystals can be recognised with the naked eye, and can be studied under a low power of the microscope.

The reaction cannot (in Chalmers Watson's opinion) be regarded as indicative of inflammation of the pancreas. A positive reaction points to disease of the pancreas, but there is, he thinks, conclusive

evidence that that may be of a functional character, and dependent on the ingestion of an excessive amount of carbohydrate foods.

(*c.*) **Bile.**—A test for bile is equivalent to a test for bile pigments.

Test for Bile-pigments.—Place a few drops of urine on a white porcelain plate, and near it lay a few drops of nitric acid. Bring the two fluids in contact by inclining the plate, and if bile be present, a play of colours will appear violet, green, red, which rapidly passes away. In doubtful cases a more delicate mode of applying this test is to filter repeatedly through white blotting-paper and apply the acid to the pigments deposited on the paper. *The Test for Bile Acids* is less certain.

(*d.*) **Melanin.**—Take some urine in a test-tube; incline the tube and allow a few drops of strong nitric acid to flow gently down the side—the development of a dark purple band at the junction of the urine and nitric acid will show the presence of melanin.

(*e.*) **Indican.**—Add 5 cc. of strong hydrochloric acid to an equal quantity of urine; heat, and the presence of indican will show itself by the development of a reddish-violet colour.

(*f.*) **Pus and Mucus.**—Take any of the doubtful sediment, and treat with concentrated caustic potash; pus will become a tough muco-gelatinous mass, mucus a thin flocculent fluid.

Blood-pigment.—This is described by Bedford, as follows:—

"If the urine be neutral or alkaline, acidify it. Then pour some tincture of guaiac (made with rectified spirit and preserved in a brown or blue glass bottle) into a test-tube, and add about an equal bulk of ozonic ether or of turpentine which has been ozonised by leaving it exposed to the light for some time. Note any trace of blue colour. If absent, the reagents are satisfactory. Then pour some urine gently on to the surface of the guaiac, and ozonised ether or turpentine solution, inclining the test-tube to do so. A blue zone forms at once at the plane of contact = blood. If the blue colour is diffused through the urine an iodide may be present. Now heat, and *if the blue colour goes* the colour is due to pus."

Acetone often appears in the urine after a general anæsthetic, and in some cases indicates a very serious *condition of post chloroform poisoning.*

Colour Tests for Presence of Acetone.—(1) To a specimen of the urine add a few drops of a freshly prepared solution of sodium nitro-prussiate, and some 10 per cent. caustic potash solution. A red colour is produced, which, if left to stand, becomes yellow, the red colour returning on adding a drop of acetic acid, and shaking.

(2) To a specimen of the urine add a few drops of a freshly prepared solution of nitro-prussiate, a few drops of caustic soda, and a little acetic acid, shake, and if acetone is present, the foam will be of a purple colour.

(3) Take a specimen of urine, to which some sodium nitro-prussiate has been added, and carefully float on the top of it a strong solution of ammonia. If acetone is present, a magenta coloured ring appears at the line of junction, and slowly diffuses upwards.

Examination of Deposits.—Before minutely examining any

urinary deposit with the microscope, its "naked eye" characters should be carefully noted. When the deposit, after standing, is small, and yet where its microscopic examination is important, the clear urine at the top of such a jar should be decanted off, and the remainder poured into a conical glass. After a second decanting, some of the subsequent deposit may be removed with a pipette, and placed on a glass slide under a cover-glass. Sir Henry Thompson advocates the simple expedient of allowing the urine to stand in a corked bottle placed with the cork downwards, The deposit which afterwards adheres to the cork can be easily examined.

Where a centrifuge is available, the deposits can be collected more rapidly and efficiently by its use than in any other way.

For our purpose deposits may be divided into two groups—

I. *Unorganised Substances* (soluble in moderately strong solutions of either acids or alkalies)—amorphous urates or phosphates, crystals of uric and oxalic acids, or of triple phosphate.

II. *Organised Substances* (more or less altered by weak acids or especially alkalies)—epithelial cells, pus, blood, or mucus, spermatozoa, tube-casts, micro-organisms, and foreign particles, which have obtained access to the urine.

For the examination of all these deposits, magnifying powers of 50 and 350 will be found sufficient.

I. Unorganised Substances.—A. *In an Acid Urine.*—(1) *Urates* form a loose deposit mingled with mucus, varying from a brick-red to a dirty yellow colour. They are distinguished from all other deposits (α) by being completely soluble by heat, (β) by forming a film on both the surface of urine and on the sides of the vessel in which the urine has cooled (*Roberts*). They may be combined with other deposits. Under the microscope they are amorphous and granular.

(2) *Uric Acid.*—Insoluble in dilute acids, soluble in caustic alkalies. May form a film on the surface, sink as a dense red deposit to the bottom, or appear as reddish granules on the sides and at the bottom of the vessel. Under the microscope the crystalline forms are numerous, but referable to combinations or modifications of a lozenge shape, or of a rhombic prism (Fig. 185, *a*, *b*, and *c*.) Their deep yellow colour under the microscope is an important character. The murexide test for uric acid or urates may be useful in confirming the microscopic examination; evaporate a few drops of urine in a porcelain basin nearly to dryness, or moisten some of the crystals, add a drop of strong nitric acid, heat till quite dry, and a reddish-brown deposit will be left; cool, and if a drop of strong ammonia be now added a reddish-purple colour will be developed. Uric acid in the urine indicates a gouty tendency, while oxalates seem chiefly derived from the oxalates of the food. Oxaluria is often associated with dyspepsia and mental depression, but by no means necessarily so.

(3) *Oxalate of Lime* (soluble in mineral acids, insoluble in water or vegetable acids) forms a characteristic deposit to the naked eye—*i.e.*, lines on the side of the glass, due to crystallisation along the

inequalities left after towelling; these differ from similar ones formed sometimes by uric acid in being finer and in being colourless; also a sediment with the following features:—An upper layer, white, hummocky, and sharply defined above; and a lower layer, softer and gelatinous in appearance, and greyish in colour. It is found in an acid urine, and is often associated with uric acid and

Fig. 185.—*a, b, c*, Uric acid; *d, g*, Micro-cocci and bacilli; *f*, Yeast-fungi; *g, e*, Mould-fungi (from *Landois and Stirling's Physiology*).

amorphous urates. Microscopically, it shows a crystalline form, referable to combinations of four-sided prisms (Fig. 186, *a* and *b*). A dumb-bell form (Fig. 186, *d*) of deposit which often accompanies the oxalate lime crystals, used to be considered another form of the substance. It is now recognised to be a carbonate of lime.

B. *In an Alkaline Urine.*—(4) *Ammonio-magnesium* or *triple phosphate* is most frequently associated with decomposition of urine, either within the body as in some cases of cystitis, or out of it, as the invariable result of exposure to the organisms of the air. In the former case, the turbidity and deposit due to altered pus will be the most striking naked eye feature; in the latter it will be the turbidity—scum and deposit—due to the fermentation.

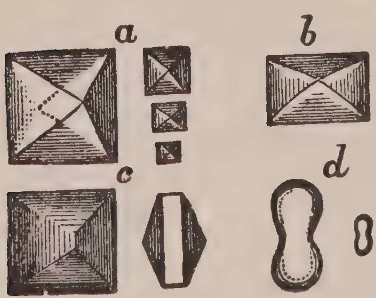


Fig. 186.—Oxalate of lime. *a, b*, Octahedra; *c*, Compound forms; *d*, Dumb-bells of Carbonate of lime (from *Landois and Stirling's Physiology*).

When deposited by itself, the triple phosphate has a snow-white appearance, with bright sparkling crystals on the sides of the glass, and forming a film on the surface (*Roberts*). Most frequently, however, it is associated with a deposit of amorphous phosphate of lime.

Under the microscope, the crystals are seen to be relatively large, prismatic with bevelled ends, and having forms modified from this by the bevelling of the various sides and angles (Fig. 187, *b*).

Associated with the triple phosphate, there is generally a deposit of *amorphous phosphate of lime*, although it is often present alone,

where fixed alkali produces the alkalinity. To the naked eye it forms a light flocculent deposit, paler than the supernatant urine, and often forming a film on the surface. It is increased by heat and dissolved in acids. In rare cases this substance is deposited in a crystalline form—stellar phosphate—and then, when in any quantity, is considered as usually associated with grave disorder in any part of the body (*Roberts*).

II. Organic Deposits.—(1) *Epithelial Scales* and *Mucus* (taken together because the latter without the former would generally not be visible). The light flocculent deposit found in healthy urine consists of epithelial scales shed probably from all parts of the urinary tract, and held together by the mucus; in women, flattened scales

Fig. 187.—Deposit in ammoniacal urine (alkaline fermentation). *a.* Acid ammonium urate; *b.* Ammonio-magnesium phosphate; *c.* Bacterium (from *Landois and Stirling's Physiology*).

from the vagina will probably be added. In men, especially after gonorrhœa, the epithelial deposit from the urethra and prostate often appears as whitish flakes and shreds, which, although indicative of no serious derangement, may occasion much groundless alarm. The epithelium from the bladder, ureter, and pelvis of the kidney, is so like the irregular cells of cancer that no deduction can be safely drawn from its presence either for or against malignant disease. Renal epithelium, generally more or less altered, is often seen in the urine when the kidneys are diseased, and accompanies a deposit of tube-casts.

(2) *Tube-Casts* consist of either fibrinous or blood-casts of the

tubules, or of the more or less altered epithelial lining of the tnbules, still holding together and shed as a whole.

The recognised varieties are, epithelial (Fig. 189), opaque granular (Fig. 190), transparent or waxy, fatty, and blood-casts (Fig. 188).

As several varieties may occur together in the same urine, conclusions must be cautiously drawn from the prevailing types, rather than from individual specimens, and only after repeated examination. With these precautions and with the patient's previous history in view, Roberts says that "the following conclusions are *generally* warranted:—(*a.*) Epithelial casts and blood-casts indicate a disease of recent origin. (*b.*) Transparent large waxy casts, mixed with dark granular casts, indicate a chronic disease. (*c.*) Epithelium and casts containing much fat, indicate fatty degeneration."

Fig. 188.—Blood-cast; altered corpuscles lying near it.

Fig. 189.—Epithelial casts.

Fig. 190.—Finely granular casts.

(Figs. 188-190. from *Landois and Stirling's Physiology*).

These tube-casts are generally present in albuminous urine, and take a long time to settle. Twelve hours should be allowed. The methods indicated before for collecting deposit should be adopted, and are specially necessary.

(3) *Pus Cells* can be recognised under the microscope in urine without much trouble. When in large quantity their presence may be inferred from the naked eye appearances alone.

(4) *Blood-Corpuscles* are not quite so easily recognised, owing to their liability to alteration (Fig. 188).

Their bi-concave character is very soon lost by imbibition in most urines. In some cases they are found shrunken. Where there is a doubt, they may be recognised by "the extreme tensity of their outline, the absence of visible cell-contents, and especially of a nucleus, and their feeble refractive power" (*Roberts*). Their colour also soon disappears.

While in an acid urine both pus cells and blood-corpuscles remain visible for several days, in an alkaline urine they are rapidly dissolved and disappear.

(5) *Spermatozoa* are easily recognised by their characteristic tadpole appearance. They are physiologically present in the urine after connection or a nocturnal emission, but in certain cases, as the result of masturbation or excessive intercourse—more rarely, however, than is popularly believed—they may be seen after straining at stool or at the end of micturition. The whitish fluid passed in many of the cases of so-called spermatorrhœa has been found to be more often prostatic than seminal. Contrary to the statement of many quacks who practise upon the bad consciences of their dupes, spermatozoa are very easily recognised in urine, even after it has begun to decompose, and are little liable to be confused with anything else.

(6) *Micro-Organisms* in urine are frequently found, and may be divided into three groups: (*a.*) Those which get access to the urine after it has left the body—*i.e.*, torulæ, sarcina, and various forms of bacteria. (*b.*) Those which have gained access to the urine after it has left the kidney, but while still within the body—*i.e.*, those associated with ammoniacal decomposition. (*c.*) Those which are excreted as foreign matter by the kidney from the blood. In this group are numerous forms, frequently micrococci, associated with septic conditions and various zymotic diseases.

(7) *Parasites.*—Of these the one most likely to prove of surgical interest is the ovum of the bilharzia hæmatobia, associated with hæmaturia, of three kinds.

(*a.*) A few drops of blood at the end of micturition. When the parasite lodges in the prostatic part of the urethra (most frequent).

(*b.*) Whole of urine bloody. Parasite in bladder (or higher in urinary tract).

(*c.*) Blood always flowing. Parasite low down in urethra.

(8) *Foreign Particles* which have gained access to the urine after it has been passed, such are particles of flax, cotton, hair, wool, wood, or feathers, the source of which it is easy to trace.

Collection and Examination of Urine from each Ureter.—The most serviceable instrument for this purpose is the separator of Luys (Figs. 191 and 192), which, from its simplicity and efficiency, replaces the more difficult procedures of catheterisation of the ureters.

The separator has the "Béniqué" curve. It consists of a central stem fitted with a sliding rod and chain in its concavity, over which a rubber covering is slipped, A. On turning a screw in the handle, B, the chain is put on the stretch, and so raises the rubber in the form of a crescentic partition, C. To each side of the rod a some-

what flattened catheter is applied, D. The two catheters and central rod, chain, and rubber are secured by a terminal screw cap, E.

Mode of Use.—See that the instrument is in working order. Plunge it into boiling water (no soda) for five minutes. Draw off the patient's urine and wash out the bladder (avoiding the entrance of air) with sterilised boric lotion. Leave 1 oz. in the bladder. If there be any doubt as to the capacity of the urethra, pass a large-sized bougie. Thoroughly lubricate the instrument and introduce, making certain that the curve is fully within the bladder and beyond the prostate. The lubricant of Krauss is to be recommended (see *Appendix*, p. 325). Examine, if necessary, from rectum or vagina. The patient is now propped up, with his feet supported over the end of the table, the separator being steadily supported in the middle line by hand, parallel with the thighs. The membranous partition is now to be raised with a few turns of the screw.

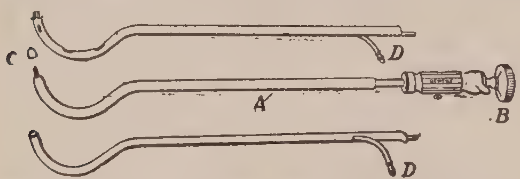


Fig. 191.—The Luys Separator detached.—*A*, Central stem with rubber membrane concealed; *B*, milled head, by the turning of which the chain is tightened; *C*, cap which keeps the end of the membrane in position; *D D*, lateral catheters, which fit against the central stem.

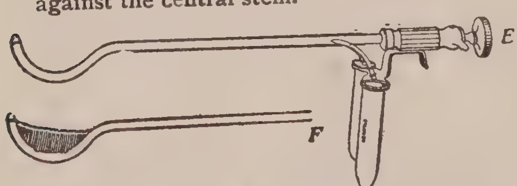


Fig. 192.—The Luys Separator mounted.—*E*, Instrument with tubes attached, but membrane concealed; *F*, membrane drawn up by tightening chain.

The boric lotion runs off rapidly, and a couple of collecting tubes, respectively labelled right and left, are introduced on the movable frame, beneath the catheters, and receive the urine. The tubes are changed every ten minutes, and the collected urine is set aside for examination as to specific gravity, urea, cryoscopy, &c., and may be centrifuged for microscopic deposits.

The functional activity of each kidney may also be determined if we inject into the glutei 4 cc. of a 4 per cent. solution of indigo carmine, sterilised, with a hypodermic needle. The colour normally shows itself in the urine within ten minutes. Where there is a difference in the activity of each organ, the different hue of the urine gives a striking demonstration of the efficiency with which the partition acts as it lies in the grasp of the bladder.

On withdrawing the instrument the bladder may again be washed out with boric lotion, and the patient sent to bed. There is rarely difficulty in passing the separator, and so little pain that an anæsthetic is not required. Some potash water may be given during use.

The separator should now be cleansed by plunging the distal part (not handle) into boiling water, taken to pieces, and carefully dried. The rubber cover serves five or six times, and is readily slipped on again if well dried and well dusted inside with powdered talc. The parts should now be re-fitted together, and then replaced in the box.

CHAPTER XXV.

THE SYPHON AND ITS USES.

Contents.—Principle and Description of the Syphon and Water-head Apparatus in Surgical Treatment—Various Applications—Douches, Vaginal, Nasal, &c.—Syringing the Ear—Washing out the Stomach and Bladder—Thread-Syphons—Syphon Pump—Bunsen's Pump—Adaptable Funnel for Waste Fluids—Tying in a Catheter.

THE object of the syphon or other apparatus on the water-head principle in surgical treatment, is to obtain a continuous stream of fluid, which may be managed in many ways.

Description of the Apparatus.—(1) A **Syphon** is an inverted **U**-shaped tube, with one arm longer than the other. Both being filled—if the short arm be placed in a jug of water, with the long end allowed to hang over the edge of the basin, the water will flow out of the end of the longer arm with a force proportionate to the distance between its lower end and the level of the water. An india-rubber tube, 5 or 6 feet in length, will serve all purposes. It should be weighted at one end to keep it under water, and may be provided with a curved metal tube to prevent it from "kinking" as it comes over the edge of the vessel. A thicker piece of rubber tube slipped over it at the bend (*Foulis*), or a piece of sheet lead wound spirally round it there, will serve the same purpose. If need be, when ready, it may be tied to the handle of the vessel. To start the syphon (*a*), sink the tube below the surface of the water, which then, of course, fills it. Compress part of the long arm firmly, and while still holding it tight, bring it quickly over the edge and below the level of the water in the vessel; now let go, and the water will flow down. Pinch the long arm till the syphon is wanted. (*b*) Suck the fluid into the tube with a syringe.

(2) Cotton or worsted threads may be substituted for the tubes. If the thread be wet, one end dipped in a basin or jug and the longer end brought over the edge, fluid will drop from the longer end exactly as if it were a syphon tube.

(3) The difference between the "syphon" and the "water-head" principle is, that the latter requires a vessel with the outlet pipe below. Instrument-makers supply special vessels for the purpose, with stop-cocks and gauges. Dr. Foulis has recommended as a cheap substitute a common tin handled mug, into the side of which, near the bottom, a stop-cock has been soldered. When the vessel is raised, the fluid it contains will flow out by the tube.

Modes of Using the Apparatus.—Either a "syphon" or "water-head" apparatus may be used :—

(1) Instead of a syringe, for irrigating wounds or abscess cavities, or for washing out the mouth (after operations), the nose, the ear ("syringing the ear"), or the vagina ("vaginal douche").

Nasal Douche, though possible with a syringe, can be best applied with a continuous stream from a syphon or water-head of about a foot's pressure. The perforated terminal nozzle should be large enough to completely plug the nostril.

The patient, who must lean over a basin, should be instructed to keep his mouth open and breathe through it, while he raises the soft palate so as to enable the fluid entering by the one nostril to flow round the upper part of the pharynx and leave by the other (Fig. 193). Warm ¾ per cent., saline solution answers very well, or a weak antiseptic.

Fig. 193.—The Nasal Douche.

In Syringing the Ear the pinna should be drawn steadily upwards and backwards while the stream of warm fluid is directed along the roof of the canal. A funnel fitted to the ear should guide the returning fluid into a basin. Care must be taken not to force a strong stream against the membrane, lest it be ruptured.

(2) When provided with a simple nozzle, as an efficient form of *enema apparatus*.

(3) *For washing out the Stomach or Bladder* (see p. 13).

The Thread-Syphons are chiefly used to *irrigate wounds* by moistening a cloth kept over their surface. A bottle containing the irrigating fluid (water or antiseptic lotion) is fixed to a cage over the wound. The amount of irrigating fluid is regulated as above. Place a mackintosh below the limb to catch superfluous lotion.

The following application of syphonage will be found to be of service in withdrawing the urine in cystitis with or without enlarged prostate; after operations for extroversion of the bladder; or after suprapubic cystotomy, to the comfort of the patient and relief of the nursing staff. Besides a douche can, some india-rubber tubing, and a pail, we require a screw-clamp, a small glass Y- or T-tube, a second piece of glass tubing bent like a capital letter S, and a third piece bent at a right angle to go into the bladder. Join these in the way shown in Fig 193. The apparatus works as follows:—

The douche can, filled with water, is fixed above the head of the patient's bed, the Y-tube is fastened with a large safety pin to the edge of the mattress opposite the patient's pelvis or loins, and the part below the Y is made to hang over a pail on the floor. The screw clamp which controls the rubber tubing between the douche and one arm of the Y-tube is then relaxed, so as to allow the water to flow very slowly, in fact, only by drops. It accumulates

in the S-tube, and as it tends to run out produces a negative pressure in the other arm of the Y-tube—that is, the one connected with the tube in the bladder. It thus withdraws urine from the bladder, and this, as it runs down the S-tube into the pail, increases the negative pressure in the bladder arm of the Y, and so on.

The amount of negative pressure obtainable depends on the distance between the branching point of the Y-tube and end of the india-rubber tube above the pail; about a foot will generally be found sufficient. A very small outlet at the clamp is all that is required, and at the fastest the flow into the clamp arm of the Y must be less than the possible outflow through the stem below, otherwise there could be no negative pressure in the bladder arm of the Y-tube. This will be better understood by considering what would happen if the conditions were reversed. If we were to diminish the outlet below the Y-tube and increase the inlet on the douche arm, the water would flow up the bladder arm of the Y into the bladder. Thus nothing is gained by increasing the rapidity of the flow beyond a steady dropping from the clamp. The accumulation in the S-tube will transform this into a rapidly intermitting flow with which the urine from the bladder is mingled.

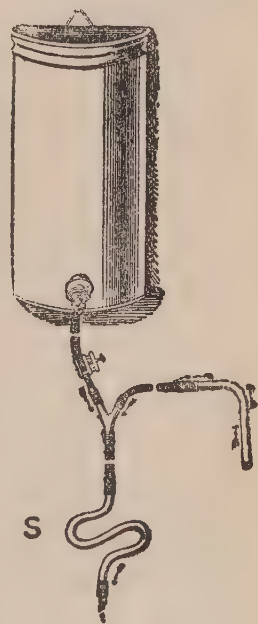


Fig. 194.

In an emergency the want of the S-shaped glass tube might be supplied by bending the rubber tube round on itself, to form a single loop as Dawburn recommends, or into a large S-shape as Keen advises. Keen also recommends a simple way of making a substitute for the T-tube. He takes a small piece of glass tubing, softens the end in a gas flame, and opens it out with any convenient piece of metal. He then cuts a *small* hole in the side of a piece of rubber tubing, and stretches it over the expanded end of the glass. When there is no screw clamp at hand a piece of bandage tightened in a single knot may be used instead. None of these substitutes are, however, as convenient as the very simple apparatus advocated.

There is much advantage in interposing a bottle in the course of the tube leading from the bladder to the Y-tube. By its use the urine is collected separately, and not mixed with water, as it must otherwise be. A large-necked bottle is fitted with a rubber stopper, into which are inserted two pieces of short glass tubing. The rubber tubing leading from the bladder is cut, and each cut end is attached to one of the tubes in the stopper of the bottle, and the bottle then placed on a stand by the bedside.

The simple form of apparatus, known as Bunsen's pump (Fig. 195), gives excellent results in similar conditions where continuous suction drainage is required. The vessel, A, is filled with water, the outflow being checked by the clamp, X. A is then stoppered

and connected with the urine reservoir, B, and the suprapubic drainage tube, C. On relaxing the clamp a vacuum is created, and the urine collects in B. The T-tube in the bladder should terminate in a rubber prolongation with two lateral apertures at its free end, and care should be taken that there is no leak at the junction of the rubber and glass tubes or at the stoppers. A little vaseline proves a serviceable luting. If the flow be too rapid it may be controlled by the clamp, X. The apparatus works easily for six or eight hours without much attention being required.

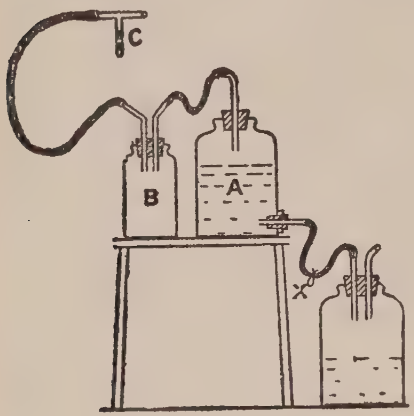


Fig. 195.

Apparatus for Carrying-off Waste Fluids.—It is often a great convenience when any cavity is being washed out to catch the returning fluids and carry them directly away by a tube into a pail on the floor. A carrying-off funnel *adaptable* to a surface of any shape can be easily made as follows :—

Take about 4 feet of copper wire (plain or, preferably, tinned), gauge No. 10—*i.e.*, about $\frac{1}{8}$ inch thick—bend the middle part into a circle about 10 inches in diameter, and twist the ends together to form a handle. Now draw a circle on a piece of paper with a *radius* which is equal to the *diameter* of the wire ring; cut a quadrant out of the circle, and we have a pattern for the mackintosh funnel. A piece of mackintosh cloth of this size and shape is then stitched together along the edges cut by the removal of the quadrant. Now fold the wide end of the funnel over the wire and stitch it in position, leaving room for its sliding easily over the wire. In fixing it, see that the stitched part of the wall of the funnel lies under the handle of the wire circle. The funnel has now to be fastened to the exit tube. Slip about an inch of glass or other firm tubing inside a piece of rubber tubing, 3 or 4 feet in length, and $\frac{1}{2}$ inch or $\frac{3}{4}$ inch in diameter. Place this end of the tubing inside the lower still open end of the mackintosh funnel and tie a piece of string firmly round the whole. The copper wire which stiffens the top of the funnel can be bent with the fingers to any desired shape, but is rigid enough to retain that shape while being firmly pressed against the patient's body. When used in aseptic cases, a piece of lint soaked in antiseptic lotions should be laid over that part of the rim of the funnel which is brought in contact with the patient's skin. The degree of pliability of the wire rim, the relatively large size of the mackintosh funnel, and the slack hold which it has on the rim should be such as will allow of the rim being easily fitted with accuracy against any part of the body.

Tying a Catheter into the Bladder.—In almost all cases it is for the male bladder that this operation is required.

The conditions rendering such a procedure necessary are various —such as to produce "vital" dilatation of a stricture to establish the urethral channel after perinæal section, or to drain the bladder. In the latter case it is not advisable to keep the same catheter in for more than three or four days at the outside, nor to maintain the drainage for much more than a few weeks at a time. For stricture twelve hours, or after perinæal section forty-eight hours, is generally long enough.

To minimise irritation, a soft instrument (soft rubber or gum-elastic) should be chosen, if it can be passed into the bladder. The instrument, when there is difficulty in passing it, may be made temporarily rigid by the insertion of a bougie which fits its calibre. After the bladder has been reached, the bougie may be withdrawn. The eye of the catheter should lie just within the bladder—*i.e.*, just at the point where urine begins to flow when the instrument is pushed in. A mark should be made on the catheter to show where it should touch the external meatus. Unless means were taken to secure it, the catheter would very soon be forced out of the bladder. The best way of fixing the catheter in the bladder is to fasten a piece of strong linen thread (waxed if possible) by means of a clove-hitch to each side of the catheter; the ends are then laid along the side of the penis, and secured to it with adhesive plaster.

Another simple way is to take two pieces of adhesive plaster about ¼ inch broad and 1½ inch long, fold each over about ½ an inch from one end so that the adhesive surfaces come together, and cut a small hole out of this folded part. Now fasten these pieces on to the catheter on opposite sides, a little beyond the mark indicating the position of the meatus. Two similar pieces, a little longer, are laid on each side of the penis, and secured with a strip of plaster carried circularly round. When the catheter is passed, it is secured in position by passing threads through the holes in the plasters on the catheter and penis respectively and tying them together. For women, a band of tape or cloth should be passed round each thigh close to the perineum, and made fast to a waist-band encircling the pelvis below the iliac crests. The catheter is secured to these thigh bands.

CHAPTER XXVI.

TRUSSES AND ARTIFICIAL LIMBS.

Contents.—**A. Trusses**—Various Forms—For Adults—For Children. **B. Artificial Limbs**—"Bearing" Points after Amputation—Sites for Amputation most suitable for the Adaptation of Artificial Substitutes—Artificial Limbs, their Nature and Mechanism—General Hints.

A. Trusses.

(*a*) **For Adults.**—A very great number of patterns of truss and of truss-pads has been introduced.

A. Trusses.—In dealing with inguinal and femoral hernia, the

support should be given by means of a pad fixed upon a steel spring passing obliquely round the pelvis a little below the iliac crests. No reliance should be placed on pads fastened merely to soft straps. Two forms of steel truss are in common use—(1) The spiral, which may be used for inguinal and femoral herniæ; and (2) the Salmon and Ody, which is chiefly used for femoral hernia. Either may be used for single or double herniæ.

(1) The Spiral Spring Truss.—*The Spring* is fashioned from tempered steel. In *length* it should extend from the pad-plate, which lies on the hernial opening, round the back of the pelvis to nearly the corresponding point on the opposite side. At the hernial end it is rivetted to the pad-plate, and the other end is tapered off for a single hernia. In a double hernia there is a plate-pad at each end of the spring. The spring has two curves—one is on the flat, by which it takes a slightly crescentic or scimitar shape; the other curve adapts the spring to the shape of the pelvis, and near the pad-plate the curve is increased. This, together with the scimitar bend, gives the "spiral" appearance to the spring. The pelvic curve should be not much greater than that of the pelvis, so that the pressure is not strong on the hernial opening so long as there is no protrusion, but the spring should be so firm that if any protrusion occurs it meets with effective resistance. The strength of the spring should vary with the muscular development of the patient and with the size of the hernial opening. As a general rule, the strength of the spring increases with its length—*i.e.*, with the size of pelvis for which it is designed. The spring for a femoral hernia is weaker than for an inguinal hernia.

The Pad is fixed to a pad-plate of soft iron, which is secured by two rivets to the end of the spring. The substance of the pad should be unyielding, and may, therefore, be of wood, ivory, vulcanite, or metal. Many makers use cork, and some employ a firmly stuffed bag of horse-hair. With regard to size and shape, the firm part must never press against the pubes under any circumstances, although the soft prolongations of the pad which are sometimes necessary for large scrotal herniæ, must necessarily lie against the bone. For a bubonocele the shape of the pad is somewhat pyriform, slightly convex in front, and not so large as to interfere with flexion. For a scrotal hernia (which dilates the external opening), a rat-tail termination of the pad is recommended to help in closing the external opening, but in very bad cases this is not enough—the hernia escapes on the inner side of the pad. For such cases Macready recommends the use of Kingdon's "forked tongued" truss. In this "the pad is carried inwards for a considerable distance and forms a tongue, which is fixed by a thong to the cross-strap near the anterior superior iliac spine of the sound side." The other fork is the downward continuation forming the rat-tail already mentioned.

For a femoral hernia the pad is bent more abruptly downwards from the end of the spring than for an inguinal hernia. Macready advises that for large femoral herniæ, Astley Cooper's "thigh belt" should be added. "The thigh belt should contain a triangular

extension of the pad downwards, which, when firmly stuffed, dips into the groove which the hernia has made for itself in the thigh, and prevents the escape of the viscera below." Should the hernia escape above the pad, or should there be also an inguinal hernia on the same side, an "inguinal fulness" must be added to the upper part of the pad.

(2) *The Salmon and Ody Truss* (single) has a pad behind at the spine as well as one in front. It is also called the "opposite-sided" truss, because its spring passes from the spine round the front of the body on the side opposite to the hernia, and thus crosses the middle line in front to reach the hernia. This gives it great security. It is chiefly used for femoral hernia, though it may be applied for inguinal hernia also.

The *pad* is usually circular in shape, fixed to the spring by a ball and socket joint. A perinæal strap is generally worn.

A *double* Salmon and Ody truss has a double pad behind, with the spring passing round each side to end in a pad on its own side. It is thus, when double, not an opposite-sided truss.

To Measure for a Truss.—It is better to allow the instrument maker to see and measure the patient for himself, but for those who are in the country this is not always possible. Some makers measure while the patient is standing, others while he is lying. In any case the hernia should be reduced. The tape should be drawn firmly if the patient is standing, more slackly if he is on his back. Young gives the following directions:—"Place the end of the measuring tape on the opening of the rupture, pass it in a sloping direction upwards to about two inches below the iliac crest, across the back to the corresponding point on the other side, thence sloping down again to the starting point. Measure for a double truss the same as for a single—*i.e.*, from and to one rupture. *Give this measure in inches.*"

In addition the maker must be told the kind of rupture—single or double—and on which side of the body, if single. If an inguinal hernia it may be well to specify whether a bubonocele or a scrotal hernia, as the latter generally requires a stronger spring and larger pad. The sex of the patient should be stated. If the occupation of the patient or other circumstance requires a strong or a light spring this, too, should be noted. One or two sizes of truss should be sent when the patient is in the country.

How to Fit on the Truss.—To avoid opening the spring too much in putting it round the body, bring it up from the thighs or slip it on sideways. Reduce the hernia in the horizontal position, put the pad over the hernial opening, and adjust the spring to the pelvis. Now support the pad in its position while helping the patient to stand erect without much exertion. See if the spring is shaped so as to fit the patient, and if the pad is directed so as to control the hernia without much traction on the straps. If not, he should try another truss or get the spring modified by the maker to suit the requirements of the case. The straps may then be adjusted, first the cross-strap, then that for the perinæum, it being borne in

mind that if the spring fits properly, the straps do little more than keep it in its place. The patient should then stoop and flex the thighs, to see that movement is not hampered; and lastly, he must cough and perhaps lift a weight to make sure that the hernia is efficiently retained.

Directions for using a Truss.—The truss must always be taken off or put on in the horizontal position, and it should be always worn while the patient is in the vertical position, night or day. If he has a cough he should also wear a truss at night, otherwise it may be removed when he lies down, but it must be re-applied before he gets up. The object is to prevent the hernia from ever showing itself again after the treatment by truss has been begun. Many cases of strangulation occur by patients taking off their truss at night and coughing down the rupture, or rising to relieve the bowels without applying the truss. A spare truss should always be kept in readiness, as well as a bathing truss covered with indiarubber.

Umbilical herniæ must be treated with a spring truss and a flat pad.

For Children.—In children, trusses similar to those used for adults are generally indicated. For umbilical herniæ the spring may be replaced by a belt.

In male infants the form of hernia almost exclusively met with is the inguinal. If the skin will not bear the pressure of a pad with the ordinary spiral truss, a pad of wool kept in place, with the looped (p. 136) or a spica bandage (plain or elastic) will often suffice; or the worsted truss re-advocated by Lund (*Hunterian Lectures*, 1885) should be employed. A skein of Berlin worsted (Pye recommends "Alloa yarn," or "five-ply or four-ply fingering"), 22 inches long, and consisting of twenty threads, is passed round the child's waist (Fig. 196). The end passing round the side opposite from the hernia is held at the seat of the hernia, while the other end is passed through it, and after encircling the thigh is fixed with tapes or a safety-pin to the waist part. Two such trusses may be kept in use, each being washed alternately. Umbilical hernia in infants, when not very bad, is best treated by two strips of plaster crossing at the umbilicus, and drawing the abdominal walls together at that point. The opening may be further supported by a pad formed by wrapping a penny in boric lint, and held in position by the strapping.

Fig. 196.—Skein of Worsted Truss for Infants.

For *irreducible hernia* in any region, where an operation is not indicated, Bryant recommends a hollow metal pad lined with wash-leather, and made to fit exactly by being moulded over a cast of the hernial protrusion.

B. Artificial Limbs.

The subject is important, not only because certain stumps are said to be better suited than others for artificial limbs, but also because a surgeon should at least be able to advise his patients as to the form of artificial limb available for their particular case and circumstances.

We shall accordingly consider the following heads :—

(1) The "bearing" points in the lower limb after amputation.

(2) The sites for amputation in the upper and lower limbs most suitable for the adaptation of artificial substitutes.

(3) The nature and mechanism of artificial limbs.

(4) General hints on the use of artificial limbs.

(1) **"Bearing" Points—After Amputation.**—As might have been expected, the best "bearing" points are the natural ones; at the heel first, then that on the bent knee. Thus, in a favourable case, after Hey's or Chopart's amputation (and there is no reason why, as a general rule, cases should *not* be favourable), the patient walks on the heel, and on what remains of the sole, without trouble. Also, in amputation just below the knee, the joint may be kept bent, and the patient can then *generally* bear his full weight upon it, although with the risk of developing a "housemaid's knee."

After these come amputations in which the skin of the heel and that of the front of the knee, respectively, are folded over the sawn surface of the corresponding articular end of the adjacent bone. Thus, in most, but not in all, of Syme's amputations, the full weight can be borne on the face of the stump. In a Carden's or a Gritti's a certain but variable amount of the weight only can be borne.

Next in order of "bearing" power would come amputations through the same articular ends of the femur or tibia, but where the covering skin had, from the nature of the case, to be taken from the lateral or flexor aspects of the limb. When the shaft, instead of the (lower) articular end of the femur or tibia, is sawn through, little, if any, bearing can ever be taken on the resulting stump, however favourable in other respects the amputation may be. Fortunately, however, the instrument-maker has other points of bearing to depend on besides the face or end of the stump. *Below* the knee a considerable part, if not the whole, of the patient's weight can often be borne on the upper ends of the tibia and fibula. *Above* the knee a considerable proportion can be borne on the muscles of the thigh by means of a lacing shield, and there are few cases where, if need be, the whole weight cannot be borne on the tuber-ischii and trochanter, by the adjustment of a padded ring like that used for Thomas's knee-splint (p. 235). The lower in the limb the bearing can be taken, the greater the advantage to the patient in walking. The instrument-maker requires to adapt his points of bearing to the particular case, sometimes distributing the weight over several parts, sometimes confining it to one.

(2) **Sites for Amputation.**—(*a.*) *In the upper limb* there is no question that above the fingers (see p. 116) the greater the length of the natural parts left—other things being equal—the better for the patient in every way. Artificial parts, more or less efficient, can always be adapted to the stumps. The surgeon's way is, therefore, clear—he must leave as much as he can.

(*b.*) As regards *the lower limb* there is much greater difference of opinion. Some instrument-makers go so far as to say that a jump is to be made from the ball of the toes to the level of a "Syme" or "Pirogoff," and that if 4 inches below the knee cannot be left to allow of a strong control of the artificial limb by the stump, the surgeon should amputate 4 inches above the knee to give room for the mechanism of an artificial knee-joint. From these views we entirely dissent.* After a careful examination of the whole subject, our conclusion is that the surgeon should take "the least sacrifice of parts" as his guide, and amputate as low as the circumstances of the case permit. He should spare as much bone as he can, and he may be satisfied that artificial limbs can be made for the stumps. The longer the limb left, the better the walking power.

(3) **Artificial Limbs.**—We cannot, of course, attempt more here than a discussion of general principles :—

(*a.*) *For Partial Amputations of the Foot* (Hey's or Chopart's), if during healing of the wound care be taken to bandage the stump well and keep the knee flexed, section of the tendo Achillis is seldom necessary. When the stump has healed, the patient bears his weight on what remains of the sole of the foot. At first there may be aching and weakness as the arch of the foot sinks down. After this has occurred there will be no further trouble, and the only artificial limb required is a stiff-soled boot, lacing well above the ankle, and having cork or other stuffing to fill the place of the parts of the foot which have been lost.

For a Syme's or Pirogoff's amputation, a cheap and useful, though not ornamental, artificial limb consists of a bucket ending in a rounded leather end, sufficiently long to equalise the two limbs, and taking its bearing either on the face of the stump or at some of the points, before mentioned, above it. When an artificial foot is desired, the axis of movement of the artificial ankle should not be below the level of the stump, as it is usually made, but is more naturally placed slightly above it. Moreover, and what is of greater importance, the face of the stump should rest not on the foot-portion—but on the leg-portion of the artificial limb, which should then be jointed to the foot-part. If this be done, the face of the stump has weight to bear, but has no friction. By the usual method—where the stump rests on the foot-piece—friction on the face of the stump is inevitable, and probably explains why so many otherwise good stumps are comparatively useless for the "bearing" of an artificial limb.

(*b.*) *Artificial Ankle- and Foot-Joints.*—Of these there are no end. The first point to understand is—What can an artificial ankle-

* See *Ed. Medical Journal* March, 1888, and 1889.

and foot-joint *not* do, that a natural one does? Next, what may it be expected to do?

A minute's reflection will make it plain that no artificial joint can imitate active muscular contraction—*e.g.*, forcible extension of the foot as in rising on the toes, and that the active balancing lateral movements of the foot can never be replaced if the natural mechanism be lost. What can an artificial foot and ankle then do? It can imitate the appearance and *some* of the movements of the original, and permit of a more or less halting gait. Marey in his analysis of the human step in walking, has shown that the trajectory

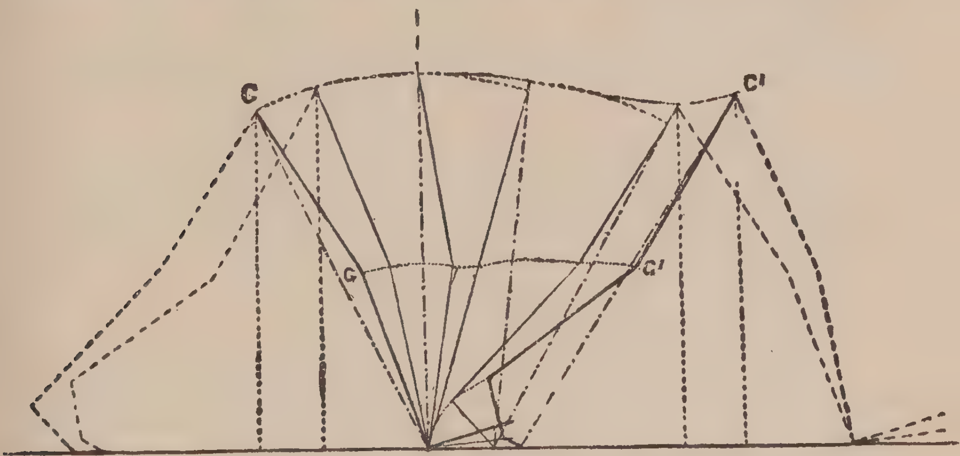


Fig. 197.—Analysis of the Step in Walking.—C C', Trajectory of the Hip G G', Trajectory of the Knee (*after* Marey).

of the knee of the supporting leg is nearly in a straight line—*i.e.*, that the knee joint neither rises nor falls as the leg passes from the position directed obliquely backward (as the heel comes down), through the vertical, to that sloping obliquely forwards as the toe leaves the ground (Fig. 197). Owing to the active muscular changes at the ankle-joint, this is attained with a longer stride than would be otherwise possible. Without such an actively changing ankle and foot, the stride must be less, but the same straight-line-trajectory of the knee can be obtained by ensuring that the leg from the knee downwards rolls forward on a sole, curved in the arc of a circle whose centre is at the knee-joint, and whose radius is equal to the distance between the knee and the sole of the boot. This produces the same effect as if the knee were the axle of a wheel and the sole of the foot part of the circumference. This curve of sole is practically that empirically advocated by Count Beaufort in his cheap limbs for the working classes. The effect of this close imitation of nature explains why it is that, in amputations below the knee, the gait of the patient with a Beaufort limb is so good, equal to, if not better than, that attained by a patient with the most expensive limb ever made. While this form of curved sole gives

such good results and is so simple, two secondary objections may be raised against it :—(1) That it is awkward in appearance. (2) That it does not yield laterally so as to accommodate itself to a side slope. To obviate the first objection, when desired a spring might be arranged so as to flatten down the fore part of the foot when not actually pressed upon, and the second may be met by allowing a slight lateral play in the foot controlled by strong springs. These objects are not necessary, however, and besides increasing expense might introduce a source of weakness into the limb. Whatever else instrument-makers may do to obtain an appearance, they should ensure that the trajectory of the knee is in a straight line as the foot rolls forward. However, an artificial foot which pivots at the ankle, or on the balls of the artificial toes, must make the knee pass through the arc of a circle, and not continue in the desired straight line. A slight amount of lateral play in the *foot* may be permitted if desired.

When a stump ends shortly above the level of any joint, the new joint may be in the form of a transverse rod working in a socket (hinge joint). When the stump comes below the level of the new joint, the axis must be made to work on two* "rule" joints, one on either side of the stump. This form of joint is said to be less lasting than the other, but is very often unavoidable.

(*c.*) *Artificial Knee.*—According to circumstances, a rule or a hinge-joint may be employed; but, to avoid friction, the bearing must always be taken on the upper of the two pieces forming the joint (see p. 301). When the artificial limb is straightened, the line of downward strain should pass in front of the axis of the knee-joint, which should then be locked so that it cannot over-extend. This imitation of nature permits the patient to bear full weight on the straight knee without any fear of its giving way. The knee will bend easily enough as the thigh flexes to lift the leg off the ground, and the swing forward will again straighten the knee for the next step. In some cases a slight straightening spring is needed. By the artificial tendo Achillis mechanism with appropriate springs, the artificial knee- and ankle-joints are always extended and always flexed together. The latter combination is useful in clearing the ground as the leg is carried forwards for a fresh step, but the double extension makes the lower limb, when supporting, pivot forwards on the fore part of the foot, and this, as we have already seen, is a disadvantage to the gait.

For cheap limbs, the knee is kept rigid while the patient walks; but in most it is made to bend by the relaxation of a spring for convenience when the patient sits down.

On these general principles it is not difficult to see how efficient and yet cheap limbs may be constructed, of which the Beaufort limbs may be taken as the type. The old-fashioned bucket and pin legs, and kneeling legs will, it is hoped, soon be replaced by as cheap but more efficient substitutes.

(*d.*) *Artificial Arms.*—Many expensive patterns are in vogue, but

* Like the joint of a foot-rule.

for cheapness and efficiency the Beaufort arm is the best. This, below the elbow, consists of a closed hand with movable thumb closing with a spring, which is opened out as the arm is moved from the side. When an object is to be grasped, the arm is moved away from the side, and the opened thumb is made to surround the object. If the body be now brought up to the arm, the spring is allowed to close the thumb, and so to secure the object.

For amputations above the elbow, besides this thumb-movement, an elbow-joint is provided, which can be either kept extended or firmly locked at a right angle, as required.

(4) **General Hints.**—An artificial limb may be ordered as soon as the stump has healed. As, however, stumps are apt to atrophy at first from disuse, then to regain somewhat as they are put to a modified use, the wearers of artificial limbs must be cautioned that alterations in the new limb and its padding will be needed to correspond to those changes.

It is better not to allow a patient to use crutches, or an inferior form of artificial limb at first, lest bad habits of walking should be learned which cannot be afterwards broken off without great trouble.

CHAPTER XXVII.

PLASTER-CASTING.

Contents.—Use of Plaster-Casting to the Surgeon—How to prepare the Plaster—How to take the Mould—How to make the Cast—How to remove the Cast from the Mould—Casting in Gelatine and Glycerine.

PLASTER-CASTING is often useful to obtain a permanent record of abnormalities, and as a means of enabling instrument-makers at a distance to fit apparatus accurately.

The stages of casting may be divided into—(1) Mixing the plaster; (2) taking the mould; (3) making the cast.

(1) *Mixing the Plaster.*—The plaster of Paris used is of good medium quality, about 9d. a stone; not the extra fine kind used by dentists, nor the coarser sort for rough castings. It should be thoroughly dry, and can be baked in an oven, or by the side of the fire, if at all damp. Take, in any common bowl, water equal in volume to half that of the mixed plaster (warm water causes more rapid setting than cold; and in winter the chill should be taken off the water for the patient's comfort, when the cast is from the living person), sprinkle lightly into the water—*without stirring*—spoonful after spoonful of the dry plaster until it rises up through the water, and shows just beneath the surface all over. There is now enough. Stir the whole rapidly, working it up from below and from the sides.

When mixed, it is ready, and, although quite fluid at first, soon becomes thick. It will be found that nearly an equal bulk of plaster and water are used, and that the mixture is only a little less than twice the bulk of water taken.

When a *plaster-cast* is to be taken from the mould, ink or some other colouring-matter should be added to the plaster for the mould as it is being mixed. The reason for this will be afterwards explained.

(2) *Taking the Mould.*—If the amount of surface to be cast is such that it can be pulled out of a one-piece mould, the process is so much the simpler. Although the pliable soft textures can be withdrawn from a plaster mould, which partly surrounds them, the extent to which this can be done will vary with the part, and must be learned by practice. A plaster-cast and mould, on the other hand, being both rigid, can only be separated when, besides not sticking, they do not enclose one another.

Suppose the back of a man's hand is to be cast. Shave off all hairs from the dorsum of hand and first phalanges—the soft hairs on a woman's or child's hand may be smoothed down with soap and vaseline—next lay the hand, fingers and thumb together, prone on a board spread with a piece of paper. Partly fill up the hollow under the wrist to prevent the plaster from getting too far round. See that the hand is well smeared with oil or vaseline. Mix sufficient plaster of Paris to cover the hand all over with a half-inch thick layer. When first made, the plaster will be too thin to lie on the hand; very soon, however, it will become like cream. In this state lay it over every part of the back of the hand and fingers, and, as it thickens, plaster it on more and more. Care must be taken to see that every part is uniformly covered; there is a risk that some parts will be as thin as egg-shell and break very easily, while others have more than their share. When every part is satisfactorily covered, leave the plaster for five or ten minutes to set. This process will be indicated by its growing distinctly, though not uncomfortably, warm. Before the mould is ready to lift, any small projection, when tested, should crack off as a whole, and not crumble under the finger. When sufficiently hard, it should be cautiously lifted from the hand.

When both sides of an object (say, the hand) are required, the mould must be taken off in two pieces. There are many ways of doing this, but the "thread" plan is perhaps the best.

Mix plaster as before, but in two portions, one after the other—one is to be laid down first as a bed—and when it is thickening and can be heaped up into a level layer, the hand is allowed to sink a very little way into it. Next make a fresh quantity of plaster, and as it thickens take a piece of strong pack-thread or thin twine, and by means of the plaster make it stick to the skin all round the most prominent part of the hand, and at the tips of the fingers if extended. Now, rapidly cover over the whole of the rest of the hand as before. The thread will remain in its position, unless disturbed. When the plaster has thickened to the consistence of cream-cheese, draw the thread steadily out through it all round.

If the right state of the plaster has been chosen, the track of the thread should remain open. Should the plaster be too soft, it will fall in on the thread's track; should it be too firm, it will crack and break rather than let the thread come through. Do not touch the mould otherwise until it has set. By cautiously inserting a knife into the track of the thread at various parts, the top of the mould may be lifted off, and the hand withdrawn from the lower half.

The *foot* is a little more difficult to manage. Two threads must be taken whose tracks overlap, and the ends of each thread must be drawn out only until it meets the track of the other. One loop of thread passes below the sole and up the leg over the malleoli, the ends being held at first above and parallel with the axis of the leg. The other parallel with the long axis of the foot passes round the back of the heel, and coming round the sides of the foot at its most prominent part, crosses in front of the great toe, where the ends hang forward. Having covered the foot with plaster, the caster must heap up the plaster on the ankle and lower part of the leg while it is soft enough to mould itself to the skin, yet firm enough not to run down when placed in position. The threads are to be drawn out as before—in this case from above, and from the front until their tracks cross, below the malleoli. The two pieces of the mould thus mapped out are, one covering the front of the leg and dorsum of the foot, and the other covering the back of the leg and sole of the foot.

(3) *Making the Cast.*—The chief points requiring attention are, how to prevent the cast from sticking to the mould, and how to obviate air bubbles in the cast. Freshly-made plaster, if poured into a mould which has not been specially prepared, will assuredly stick to it. The simplest and best way to prepare the mould is to soak it in water for an hour or two before it is needed. To test for sufficient soaking, watch, after the mould is taken from the basin, whether water remains on the plaster, or dries in. If the latter, the pores of the plaster are evidently not yet filled with water, and further soaking is needed. If the mould be quite soaked, the fresh plaster will lie in the most perfect contact with every detail of its surface without uniting to it. In addition to thorough wetting, the surface may be painted over with olive oil or be dashed over with soap-suds, and then again with pure water (olive oil painted over the surface of a dry mould is almost at once sucked in and becomes useless, unless by many repeated coats the plaster is filled with it. Boiled linseed oil after two or three coats will form a varnish on the surface, but it is apt to impair the sharpness of the cast, unless care is taken to limit the amount).

The only way *to prevent air bubbles* from forming between the mould and the cast is to pour the plaster slowly and by instalments into the mould, and to keep constantly shaking and turning the mould round and round all the time. Sometimes it is an advantage to pour the fluid plaster into and out of the mould once or twice, in addition to turning it round and round. If plaster be poured in

without these precautions, air-bells will certainly disfigure the cast. When the mould is nearly full, a loop of string should be pushed into the plaster to hang the cast by afterwards.

(4) *Removing the Cast from the Mould.*—Except in almost flat casts, this must be done at the expense of the mould. In all ordinary casts, only one copy can be made from the original mould. Additional copies can be taken from this by making either an elastic gelatine mould or a plaster "piece-mould."

The plaster-cast, which has been filled into the mould, should be set aside for twelve hours. With a chisel and hammer the mould must then be chipped away piece-meal, care being taken not to let the chisel cut into the cast. The advantage of staining the plaster of the mould will now be apparent. It will be found an advantage to begin at the edges, and special care must be taken of any projecting or thin piece of the cast lest it be broken off with the mould.

To harden the plaster of Paris it should be *slowly* dried, then soaked in a saturated solution of alum, and slowly dried again. This improves it greatly.

Boiled linseed oil softens the surface of the plaster.

If the cast is to be painted, one or two coats of Damar varnish or of size, as a preliminary, will prevent the paint from being absorbed too quickly by the porous plaster.

(*a.*) *A Gelatine Mould* is made by suspending the cast, bone, or other object to be copied, in a wooden box large enough to give an interval of at least an inch between the object and all sides of the box. Into this is poured strong melted gelatine, or the glycerine and gelatine mixture (p. 307). When the mould is cold, the sides of the box are taken off, and a cut made in the gelatine all round, half way up the most prominent parts of the object. After lifting off the top half of the mould, the object can be pulled out of the lower half. The two halves should then be laid together, and a hole cut out of the upper one, opposite its highest point. The sides of the box are now replaced and bound in position, and, in addition, the top of the mould must be held down to prevent the plaster from escaping, leaving, of course, the top aperture free. A plaster-cast can then be run into this gelatine mould, which, from its flexibility, can be lifted off from the rigid cast without injuring it.

For small objects a small bowl serves well. The gelatine can be lifted out, cut as desired, and replaced in position.

(*b.*) *A "Piece-Mould"* is made of plaster of Paris, and being rigid as well as the cast, must be made of many pieces, each of which can be lifted off without going round a corner. The object to be copied is first mapped out into areas where casts will lift off; the first area is banked round with clay, the second and succeeding pieces are ranged round the first—blank sides being banked up, and already made "pieces" being smeared with vaseline to prevent succeeding ones from sticking to them. When the whole is complete, the inner surface is covered with boiled linseed oil; and the pieces having been fitted together are bound with string, and the cast is made through a hole left for the purpose.

Casting in Gelatine and Glycerine is done as follows:—

(1) *Preparation of the Material.*—Take of "No. 1" gelatine (this is like strong clear glue), say 6 ozs. (by weight), soak it till quite soft and swollen, afterwards dry it slowly until just pliable. As it has now the minimum of water necessary, melt it in a water bath, and add 6 ozs. (measure) of clear glycerine (not necessarily purified). When the two are thoroughly mixed, the material is ready. To render it opaque, add, while it is still hot and therefore fluid, small quantities of a thick paint made by rubbing up oxide of zinc in glycerine. When a skin colour is wanted, a little vermilion is required to give a warm life-like hue. Should tumours or other objects be cast, the prevailing colour can be given with water-colour as required (tubes of moist water-colour sold at 2d. each will be found convenient). Several pounds of this mixture may be made at once. A cook is a good ally to have for the purpose.

(2) *Preparation of the Mould.*—From the part to be cast, a mould in plaster of Paris must be taken in the ordinary way. It will be found best to limit the casts to those whose moulds can be removed from the organ or living body in one piece. When both sides are moulded at once, the gelatine cast is by no means easy to extract from the mould. After the mould has been removed from the body the cast may be taken from it at once, provided that the cast be taken out as soon as it is cool, *i.e.*, in about 2 hours. If it be left longer the gelatine mixture becomes softened by the moisture of the plaster mould. Where a cast of a pathological specimen has to be coloured from nature however, the sooner the colouring is done the better. The mould if not required at once should be slowly dried, soaked in alum solution, and dried again before being put away. When thus dried and hardened any number of casts may afterwards be taken from it without further preparation. The gelatine mixture cast then does not come off quite so easily as when the mould is moist but prolonged contact does no harm. It will be found convenient to bank up the mould with clay before pouring in the heated mixture.

(3) *Making the Cast.*—Melt the gelatine and glycerine previously prepared, and pour it into the banked up mould, being careful to roll the melted mixture backwards and forwards well over the face of the mould, so as to get rid of air bells. As the heated substance tends at first to run into the hollows and leave the raised parts of the mould with a very thin coating, the operator must keep ladling up from the hollows, and as the substance cools, it will become sufficiently tenacious to remain on the upper part.

(4) *Making a Plaster Bed for the Cast.*—While the cast is still in position in the mould, its reverse side must be covered with lint or wool, and this in turn covered with plaster of Paris, either pure or mixed with cotton wadding, oakum, lint, wood-wool, &c. This must be made to fit into the hollows and elevations of the back of the cast, and when set it is to be removed so as to be dried. The cast, when cold, can be easily drawn, or rather peeled, out of the mould, and it will be found to be an elastic cast of what is wanted. When placed upon its plaster of Paris backing, it will preserve the shape which it had while in the mould.

(5) *To Paint the Cast as required.*—Use water-colours when a dry surface is to be imitated, oil-colours when the surface has to appear moist. The water-colour may require several coats. Finally, arrange an edging of black velveteen or other material to hide the irregular margins and give a finish.

N.B.—The advantages of this method of casting are its likeness in

appearance and texture to flesh, and the great number of copies which may be taken from the same first mould. The disadvantages are, the possibility that it will not keep really good for more than eight or ten years, and the greater time required to make a cast in this than in plaster of Paris.

Price.—The cost of the materials amounts to about 1s. 6d. per lb. of the mixture.

Clay which remains always moist and ready for use may be made by mixing powdered pipe-clay with glycerine instead of with water. It should be kept in a damp place.

Casting Anatomical or Pathological Specimens in Papier-maché.—The *moulds* are of plaster of Paris, and the objects must be such that each mould can be lifted off from it in one piece. The interior of the mould must be well smeared with vaseline, tallow, or other greasy substance to which paste will not stick.

The *casts* are made either of cellulose or of tough absorbent paper, such as "drying" paper. Cellulose very suitable for the purpose is sold as a surgical dressing (Robinson's cellulose dressing). This material is worked up into a thick pulp with strong flour or starch paste. The pulp is then pressed with the fingers or a spoon into the well-greased mould. When the surface of the mould has been uniformly covered with a layer of cellulose pulp about ⅛ of an inch thick, strips of absorbent paper moistened with starch paste are laid over the cellulose pulp, till there are several layers of paper. The last layer should consist of muslin or "butter cloth" moistened with the starch paste. If paper be employed throughout, a piece of Robinson's (Liverpool) "Robosal" blotting-paper is laid on a flat plate, and the paste is rubbed into it on both sides till the paper is limp and soft. While the softened paper is still lying flat on the plate, scraps are torn from it, so as to leave their edges frayed and thin. If necessary the paper can be torn into thin films where finer surface markings are to be cast. Beginning at the margin of the mould on one side, the operator lays on a piece of the torn softened paper, and presses it with his finger or a stiff brush firmly into the irregularities of the mould. Overlapping this, he puts on another piece, and another, and so on until the whole of the mould is covered, being careful to avoid wrinkling the soft paper. Over the first layer a second is laid, and sometimes a third. For small casts this will suffice, but for larger casts an additional layer of "rope" brown paper or of muslin, soaked in paste as before, is to be applied in the same way. It is advisable to put on all the desired layers at once, so that in drying they may shrink uniformly. It is also important to let the paper stick to the margins of the mould by leaving them ungreased. This insures a good shape. When all the required layers have been put on, the cast is dried. Slow drying in free air and warmth is preferable, and takes from twenty-four to forty-eight hours, but quicker drying in a slow oven may be used if need be. When the cast is dry, the inside is painted over with a coat of spirit varnish; the paper is then cut from the mould at the margins, and the cast will be found to have shrunk away slightly from the surface, and thus to be loose. With care it can then be worked out from the crevices and corners. The rough edges are next trimmed with scissors and bound with blue paper. A thin layer of size is then laid over the cast. As soon as this is dry the necessary painting can be carried out. Oil colours should be used, mixed with turpentine if a dry surface is wanted, or mixed with plenty of megilp and afterwards varnished if a moist surface is to be imitated. The time required for making each cast is about the same with papier-maché as with other materials.

CHAPTER XXVIII.

POST-MORTEM EXAMINATION.

Contents.—Preliminaries—Special Examination: the Head—Neck and Thorax—Heart and Lungs—Abdomen—Spinal Cord.

THE practitioner may be called upon to make a *post-mortem* examination, either in private or in a mortuary. In private practice it is well to be provided with a plentiful supply of newspapers, a couple of old sponges, mackintosh, cotton wadding, twine, and one or two jars, in addition to the usual case of instruments. One or two stoppered bottles, containing a saturated solution of corrosive sublimate, are required to receive portions of tissues for microscopic examination, and one filled with Müller's fluid for nerve and brain preparations.

Preliminaries.—It is always advisable to have an assistant to take notes as the examination proceeds, more especially in medico-legal cases. Should viscera or portions of structures be removed in such cases, they ought to be conveyed in sealed cases. The body should be lifted from the coffin, and laid on a long table. The grave-clothes should be most carefully removed, and laid aside in due order, and the pins with which they were secured retained in position for re-insertion. The general appearance and state of nutrition, rigor mortis, and hypostatic congestion should be noted, and the length of the body and its thoracic circumference ascertained. Local peculiarities, such as œdema, birth marks, deformities, cicatrices, wounds, and the condition of the pupils should be described. Newspapers are now to be packed under and around the body. The part on which interest chiefly centres should be first examined.

Special Examination—The Head.—To reflect the scalp, the knife should be entered deeply behind the ear with the back directed towards the bone and the edge towards the skin. It is now firmly pressed against the skull-cap, and carried across the vertex to the opposite point. The two flaps thus formed are to be thrown well down, detachment being effected by means of the handle of the knife, aided by a few touches with the blade. The pericranium and attachments of the temporal muscles are now divided by sweeping the scalpel around the skull, about three-quarters of an inch above the upper angle of the orbit, and half-an-inch above the occipital protuberance behind. The saw is more easily managed if the table be low. It is advisable either to stand on the left side of the cadaver, and grasp the frontal flap with the left hand, or to stand on the right side, and steady the head with the left hand wrapped in a towel. The saw is now carried, at the marked out level, lightly through the *outer* table, except at the temporal ridges and occipital bone, where the *entire* thickness of the skull-cap should be divided, care being taken not to injure the dura mater or the brain. The chisel may now be inserted and detachment completed by means of a few smart strokes

with a mallet; or by merely rotating the chisel in the saw-cut, the skull-cap may be prised off.

[*In Medico-legal Cases*, and where fracture of the cranium is suspected, the saw should divide the entire thickness of the bone everywhere, as the chisel is apt to make cracks and fissures. If the skull-cap be firmly adherent, as in children, the dura mater must be carefully divided all round with a probe-pointed bistoury, and the anterior and posterior attachments of the falx severed.]

On removal of the calvarium, the tension and condition of the dura should be noted; the great longitudinal sinus slit up and examined; the anterior end of the falx cut; and the dura divided all round, so that it may be raised and its under surface studied.

The pia mater and cerebral surface may now be investigated, after which the brain has to be removed as in the dissecting-room, viz.:—by raising the frontal lobes, dividing the nerves *seriatim*, carefully cutting the tentorium along its attachment to the temporal bone, and severing the medulla and vertebral arteries as low as possible. The brain may now be laid aside in the skull-cap, while the base of the cranium is carefully examined, its sinuses opened, the dura stripped off in a search for fractures, and the condition of the middle ear ascertained.

Attention is now directed to the brain. The lateral ventricles may be laid open by horizontal slices from above downwards, and the basal ganglia exposed by transverse sections. The cerebellum is cut into vertical and transverse sections, but the nature of the examination must largely depend on the character of the special lesion.

Neck and Thorax—The viscera of the neck and trunk are reached by a mesial incision which extends from the chin onwards, by the left side of the umbilicus, to the pubes. By entering the peritoneal cavity at the ensiform cartilage, the fingers may be introduced and used as a director, so that the bowels are shielded while the abdomen is opened. The cage of the thorax is exposed by bold sweeps of the knife on the sternum and ribs. The sterno-clavicular articulations should be opened, the costal cartilages divided rather obliquely inwards close to the ribs, and the diaphragm separated below. We are thus able to throw the sternum and cartilages upwards, and to complete its disarticulation. The position and condition of the thoracic viscera may now be studied, and before they are handled we should also note the condition of the abdominal organs. The skin and pectorals should be tucked over the ends of the ribs, so that the hands are protected as they are introduced to explore the pleural cavities. The pericardium is now to be opened, and the heart examined *in situ*.

Heart and Lungs.—By following the course of the blood through the heart, we arrive at a conclusion as to the amount it contains, the state of its walls, valves, and cavities. The right auricle is opened by an incision, throwing the superior and inferior venæ cavæ into one. The right ventricle is next to be laid open by an incision immediately to the right of the septum; the left auricle by cutting from the entrance of the pulmonary veins downwards and

forwards, in front of the appendix; the left ventricle by an incision along its anterior surface, immediately to the left of the septum. The heart may be now removed by dividing the great vessels, and the competency of the valves and state of the coronary arteries ascertained. The lungs may next be separated, and cut in section from base to apex. If necessary, all the organs of the neck and chest may be removed *en masse*. This is done by dissecting back the skin of the neck, and then thrusting the knife through the floor of the mouth, so as to divide the mucous membrane close to the jaw all round. When this is done, the tongue may be pulled downwards and outwards, and as the larynx, trachea, œsophagus, and great vessels, are pulled forwards, they may be stripped from off the prevertebral muscles and cervical vertebræ. The vessels passing over the first rib are next divided, the contents of the posterior mediastinum, as far as may be, detached from the vertebræ, and the structures piercing the diaphragm cut; whereupon we may lift out everything – and examine the parts in detail. The larynx, trachea, bronchi, and œsophagus should be slit up.

The Abdomen.—An inspection having been made prior to removal of the thoracic viscera, the abdominal organs may be now more carefully examined, and, if necessary, removed. For this purpose, double ligatures should be applied to the cardiac and pyloric extremities of the stomach, the beginning of the jejunum and the sigmoid flexure. The bowel may be removed for complete examination by cutting between the ligatures and dividing the omentum and mesenteries. The stomach, liver, duodenum, and pancreas may now be removed together. The duodenum should be laid open, and the patency of the bile-passages ascertained by pressing upon the gall-bladder, and by introducing a probe-pointed knife and slitting them up. Sections may be made of the liver and pancreas, and the stomach opened. The kidneys, ureter, and bladder, together with the rectum and ovaries in the female, may now be removed. The size and consistence of the kidney should be noted, and also the thickness and adhesion of the capsule. It should then be laid in halves with a knife, the pelvis opened, the ureters followed up, and the bladder incised.

The Spinal Cord is reached by laying the body prone, and making a mesial incision from the ligamentum nuchæ to the sacrum. The arches of the vertebræ should now be exposed, divided with saw and chisel, and removed as in the dissecting-room.

At the conclusion of the autopsy the organs may be carefully replaced, and the incisions closed with a continuous suture. The body should be left exactly as found, the grave-clothes replaced, and the most scrupulous care exercised to avoid leaving even the trace of a stain. The operator's hands should be held from time to time in running water from a tap, if possible, or washed with turpentine and carbolic lotion.

APPENDIX.

A. Direct Transfusion of Blood.

The technique of this procedure has recently been much simplified. A few years ago it was thought to be necessary to suture the lumen of the artery of the donor to that of the vein of the recipient with a very fine needle and extremely thin silk. Now, however, successful results are obtained under two important modifications of that delicate and difficult procedure—*i.e.*, (1) the union of the vessels through the medium of a paraffin-lined tube, whose ends are tied into the vessels, and (2) the possible substitution for the donor's artery of one of his veins, in which the blood pressure is raised by means of a constricting bandage tied nearer the heart. The methods available are known as vein to vein and artery to vein.

Apparatus Required.—Tubes, paraffin, scalpel, fine artery and dissecting forceps (one at least mouse-toothed). Aneurism needle; Crile's artery clamp, or strip of rubber and artery forceps; fine scissors, ligatures and sutures. Local anæsthesia apparatus (p. 26). Warm normal saline.

Tubes.—These may be of glass or metal, and should be kept ready against an emergency.

For *artery-to-vein* transfusion, Juffier recommends three straight, thin-walled silver tubes, about 3 cm. long, with calibres of 1½ mm., 2 mm., and 2½ mm. respectively.

N.B.—If the outer surfaces of the ends of the tubes, whether metal or glass, are roughened or grooved, they can be tied firmly into the vessels without the need of any expansion or contraction of the tubes themselves. Tubes about 5 or 6 cm. long and of 3 or 4 mm. in diameter might also be provided. An oblique opening facilitates introduction. Metal tubes have, with a relatively thinner wall, greater strength.

For *vein-to-vein* transfusion similar tubes of larger calibre may be used of glass or metal, but for greater convenience specially curved glass tubes have been recommended. They are about 5 mm. in diameter, and are of the shape and size indicated in the diagram (Fig. 198). The S-shaped curve is used when the arms of the donor and recipient lie shoulder to shoulder (Fig. 199); the single curve when the arms lie with the hand and shoulder in contact.

The longer the tube and the greater the curve the more likelihood there is of clotting.

Paraffin is used to coat the interior of the tubes, so as to diminish the tendency to clotting. Some recommend a paraffin melting at 122° F., others recommend a mixture of paraffin 2 parts, petrolatum vaseline 2 parts, stearin 1 part. The paraffin should be sterilised by being heated for 10 minutes to about 266° F. in a metal vessel

The tubes, previously boiled and dried over a flame, are then dipped into the melted paraffin, which is allowed to run through them several times. When lifted out, the drop of melted paraffin which hangs on to the dependent end of the tube is removed by being touched with sterile wool or gauze, and with similar material the external coating is removed when cool. The tubes are then laid aside, wrapped in sterile gauze, and before use are laid in normal saline solution.

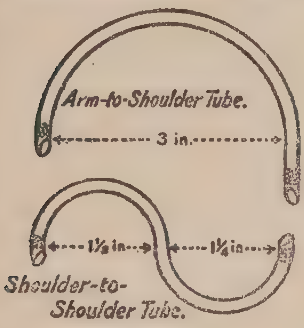


Fig 198.

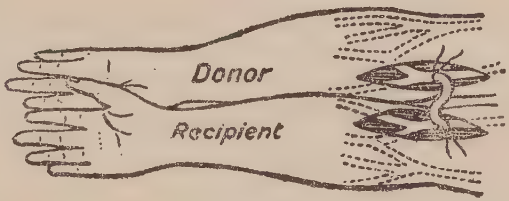


Fig. 199.

Technique of Vein-to-Vein Transfusion.—A suitable healthy donor having been obtained, the surgeon decides which veins are to be used in donor and recipient ; those at the elbow, for instance. To facilitate the choice, the veins may have to be temporarily dilated by the use of a bandage.

Both persons should be recumbent, and the best position for maintaining the arms in contact should be carefully studied and arranged for.

1. Purify the skin of both arms for about 6 inches above and below the elbow.

2. Inject the skin over the selected veins in both arms, beginning with the recipient, and apply an elastic bandage round the upper arm of the donor to cause distention of the veins.

3. Expose and isolate an inch or two of the recipient's vein ; pass a double ligature round it, and tie one thread as low (distally) as possible, leaving the other thread in position.

4. Deal similarly with the donor's vein only, tie the first thread as high (proximally) as possible, so as to have some play on the vein when the tube is fixed in, then put a light clamp or rubber band on the distal part of the vein.

5. Remove the selected tube from the saline solution, and insert it into the *donor's* vein thus :—Pinch up a fold of the vein with fine mouse-toothed forceps a little below the ligature, and with scissors snip obliquely through the vein in a distal direction for about three-fourths of the circumference. This gives a " V " shaped flap of vein wall with the apex pointing to the tied ligature ; now lift up the flap with the forceps, whose grasp has not been relaxed, and insert the tube. Tie the second thread over the roughened part of the tube end, and divide the vein between the first ligature and the tube now

fixed in position. Wrap the tube and attached vein in a gauze swab moistened with saline.

6. Open the recipient's vein a little above the ligature with a similar flap, only cut it in the reverse direction—*i.e.*, upwards—so as to have the apex of the V pointing distally

7. Relax the clamp on the donor's vein so as to let the blood flow gently through the tube (an assistant's finger on the vein is a simple way of regulating the flow), and quickly introduce the free end of the tube into the recipient's vein through the cut held open for it by the V-shaped flap in the bite of the fine forceps. Tie the second thread as before, and let the blood flow. The recipient's vein will at once swell. (Should it seem advisable, the recipient's vein may also be divided between the first ligature and the tube.)

8. Continue the flow for about twenty minutes unless contra-indications arise from the side of donor or recipient.

9. Remove the elastic bandage from the donor's arm.

10. Ligature the veins beyond the tube in each case, and cut away the tube with the piece of vein attached. Apply a dressing.

Artery-to-Vein Transfusion (read the previous directions).—As a general rule the donor's radial artery is selected and some convenient vein in the recipient's arm or leg (internal saphena, for instance, just above the ankle, or, in an infant, the femoral vein in Scarpa's triangle).

(*a*) Arrange the two persons and the selected limbs, purify the skin, and inject the local anæsthetic, as in the vein-to-vein transfusion.

(*b*) Expose, isolate, and ligature the recipient's vein as before (see 3).

(*c*) Expose and isolate the radial artery for about 2 inches, securing and dividing any branches given off so as to leave it free.

(*d*) Pass a double ligature round it, and tie one thread as low down (distally) as possible. Clamp the vessel with Crile's clamp, or elastic thread, as high as possible.

(*e*) Open the vessel with a V-shaped flap, as recommended for the vein (5), taking care to make the apex of the V point towards the tied ligature—*i.e.*, distally—insert the tube, and make it fast with the second thread.

(*f*) Now free the artery and attached tube by cutting across the vessel between the ligature and the tube.

(*g*) Allow the blood to flow gently, and insert the tube into the recipient's vein, and fix it there, as already described (7).

(*h*) Relax the clamp entirely, but have an assistant's finger ready to regulate the flow if the heart should be embarrassed by a too rapid flow into it. Pulsation will be visible in the vein. This should be watched and tested also by palpation every few minutes 3 or 4 cm. above the tube.

Tuffier recommends that the flow should continue for 12 to 15 minutes if the tube be 2½ mm. in diameter; for 20 to 25 minutes if it be smaller.

(*i*) Ligature the artery and vein beyond the tube, cut it free, and dress the wounds.

Appendix B.

Electric Hot-air Bath.—An admirable hot-air bath for use in cases of shock from burns or other cause has been recommended. A large cage, covered by a blanket, is put over the patient's body. Into this is led an electric lamp (16-candle or less) surrounded by a wire frame to keep the blankets from being singed. A long thermometer is tied to the cage, leaving the index outside the blanket. The nurse keeps up a temperature of about 110° F., and regulates the heat by turning down more or less of the blanket covering the cage. This plan has given great satisfaction.

C. Ambulant Treatment of Fractures.

THIS method, extensively used in Germany and America, enables a patient to use a recently broken leg in walking, by transferring the "bearing" to a point above the seat of fracture. Although many apply the "ambulant" dressing at once, we prefer to wait until the swelling has subsided. Massage, in the form known as "effleurage," will greatly hasten this, and in two or three days the parts will be ready for the ambulant splint. During the interval the injured limb must, of course, be steadied with a "box," "Cline," "MacIntyre," or any other splint which the surgeon may be accustomed to use.

Required—(1) Plaster of Paris bandages (see p. 247).

(2) A pad of cotton wool, 1½ to 2 ins. thick, to fit under the sole of the foot.

(3) Flannel or domet bandages, some spare cotton wool and gauze.

(4) A pail of water, and old sheeting or mackintosh cloth to protect the bedclothes.

Two assistants are required in order to hold the leg in position. Some think that the foot should be steadied with the fingers of the assistant, some prefer to apply pieces of gauze, one to lift the heel, one to produce extension. These are afterwards included in the bandage. The surgeon begins by fixing the pad of cotton wool to the foot with a domet bandage; in so doing he may with advantage fill up the hollow *below* the malleoli with cotton wool, so that the plaster bandage cannot carry the malleoli upwards when the patient is walking. The domet bandage is then carried evenly up the limb, and extends a little beyond where the plaster of Paris is expected to come. This bandage is to act as padding; some apply the plaster of Paris next the skin, and some put on a thin layer of wool; the flannel or domet bandage, however, seems to us preferable to either of these methods. When the limb has thus been prepared for the plaster of Paris bandages they are placed in a pail of water, one or two at a time. Each must be laid vertically—*i.e.*, with one end of the roll at the bottom, and the other towards the surface to allow the air bells to escape as the water sinks in. As it is taken out, the bandage is gently pressed to get rid of the superfluous water, and it is then ready to be applied to the limb, which is now being held in

position for the purpose. Experience has shown that the plaster case is especially apt to give way on the sole and at the ankle, and at these places an extra number of turns must be put on. The sole is thickened by bringing the bandage many times backwards and forwards from the toes to the heel, with occasional turns round the foot to keep these in position When this part has been well begun the bandages should be carried up the leg, taking care to avoid creases and wrinkles in the deeper parts, and especially just below the knee where the weight is to be borne. As the knee is to be left free to bend, the bandage must either stop short of the back of the knee, or, if carried up there at first, it must be afterwards cut away behind; the first method is easier and is quite as efficient as the second, although some prefer the latter. The bandages are then laid on layer after layer until it is about nine ply thick all over, and about twelve or fifteen at the ankle and on the sole. The splint must be as tough and light as possible, therefore the various layers should be rubbed in upon one another, but no extra plaster should be added beyond what can be incorporated in the fibres of the gauze. When sufficient bandages have been applied, the surgeon should see that everything fits nicely about the knee; there should especially be no pressure in the popliteal space, and the colour of the toes should be looked to. The splint can be easily moulded with the hands before the plaster sets. It is better not to put any strain on the splint till the plaster is not only set but dry. The patient may, therefore, with advantage be put to bed for twenty-four hours, the splint being meanwhile exposed to the air. At the end of this time, the patient gets up and begins to walk on the leg now encased in the splint. At first, of course, he can only limp and needs support, but before long he can move about with comparative freedom. A cover of felt or leather should be made to protect the case as much as possible from tear and wear. The weight of the appliance, the rigidity of the foot, and the increased length of the limb caused by the foot-pad, all taken together, make some patients despair at first of being able to walk with the splint; but in a few days they get used to the new condition of things, and in about a week they can move about with surprising activity and freedom. The splint is allowed to remain on until the fracture has had time to consolidate. When it is removed, the condition of the limb is carefully examined, and if union has taken place the patient is encouraged to use the leg more and more.

The same principles may be carried out in Fracture of the Thigh.

D. The Microscopical Examination of Secretions and Discharges.

THE microscopieal examination of secretions and discharges has now become almost as much a matter of routine as the examination of the urine. The presence of organisms in wounds, blood, or pathological products is of great significance and interest. An Abbé's condenser and high magnifying powers are to be employed. The fluid should be

obtained fresh, and spread on very fine cover-glasses. It is obvious that cover-glasses and instruments must be absolutely pure. The glasses, if dirty, should be soaked in nitric acid, and may always be kept for use in strong acetic acid, from which they are removed and dried with a clean cloth before use. A drop of the discharge to be examined is lifted on the point of a needle—which has just been purified by heating to redness—and spread in a fine film over the surface of the cover-glass. A couple of films may be obtained by placing a drop between two glasses and pulling them asunder. The film is then carefully and thoroughly dried by holding it for a little while above the lamp. Finally, just before staining, the cover-glass should be drawn thrice through the flame of a Bunsen burner at the rate of a long pendulum swing; this fixes the film, and makes it stain more readily.

Staining.—Place on the film for sixty seconds a drop of a 2 per cent. watery solution of methyl aniline blue, with 20 per cent. absolute alcohol added; wash off with a gentle stream of distilled water, and examine. In the case of blood, the stain should be a half-saturated alcoholic solution.

Gram's Method.—Prepare a watery solution of aniline oil by putting a few drops of the oil into a test-tube, adding about half an ounce of water, and after shaking, filter. Add to this, in the proportion of 1 to 10, a saturated alcoholic solution of gentian or methyl blue.

Let the cover glasses stain in this for fifteen to thirty minutes. [Sections require twice as long.] Then *at once* place them in Gram's fluid —Iodine, 1 part; iodide of potassium, 2 parts; water, 300 parts; or as a substitute for this, add tincture or liniment of iodine to water, till of a dark-sherry colour. They should remain in this till of a dark-brown or black colour. They should next be transferred to *absolute* alcohol to decolorise, and then placed in a weak watery solution of Bismarck brown or eosine for the contrast stain, after which they should be washed in distilled water, laid to drain on blotting-paper, end on, and, before mounting, held about 1½ foot above the lamp to dry. A drop of Canada balsam dissolved in xylol serves for mounting.

The *bacilli of tubercle* may be stained after the manner of Gibbes, with whose reagents full instructions are supplied. The following method, a modification of Neelsen's, has also been recommended:—

Fuchsine, 2 grammes, ...	=	2 per cent.
Absolute alcohol, 20 cub. cent., . .	=	20 ,,
Water, containing 5 per cent. of carbolic acid, 80 cub. cent., ...	=	80 ,,

Place some of the solution in a watch glass over a spirit-lamp, and float the cover-glasses, film downwards, on the stain. Heat gently, till steam rises, for five minutes. Place in 25 per cent. sulphuric acid for one second; transfer to absolute alcohol till decolorised. A contrast stain is now got by placing the cover-glasses in watery solution of methylene blue for half a minute, after which they must be washed in distilled water and mounted. The tubercle bacilli come out pink, and other organisms and structures blue.

In order to obtain satisfactory evidence of the presence of tubercle bacilli in the urine, it is best to have a catheter specimen. The catheter should be boiled and lubricated with glycerine, while the meatus should be washed with corrosive lotion and then with sterile water. The urine is then received into a sterile vessel. We thus avoid any external con-

tamination, more especially that of the smegma bacillus, an organism which, in appearance and behaviour under staining reagents, so resembles the tubercle bacillus that it is not readily differentiated.

Gonorrhœal Pus.—The characteristic gonococci are most plentiful during the early acute stage. The film may be examined after staining with methyl blue in the ordinary fashion. Gonococci are distinguished, not only by their appearance, but also by their reaction to staining reagents. Thus, in a case of mixed infection, where other microbes abound, we find that the gonococci become *decolorised* by the use of Gram's method; and further, if we now treat the preparation with the carbolic fuchsine used for tubercle, only diluted 10 times with water, the gonococci take up this stain, and so present a marked contrast to the other organisms.

Diphtheria.—The Löffler bacillus may be found in quantity on a membrane, and a film preparation is easily made. In many cases, however, a culture is necessary to make a definite diagnosis. Valuable information on this point will be found in the Handbook of the Clinical Research Association, and where practitioners are not in touch with some of the well-known laboratories of the medical schools, they will do well to avail themselves of the services of the Association.*

E. Antitoxins.

Antitoxins of various kinds have been administered for the purpose of conferring a more or less enduring immunity against certain diseases or of curing them when they have been contracted.

The beneficial action of the **diphtheria antitoxin** is well established. Its use should be begun early. The preparations issued by Haefliger & Co., of Bern (Prof. Tavel's), by Schering (Aronson's), and by the British Institute of Preventive Medicine are to be had at most leading dealers, and directions for use are issued along with the drug.

Tetanus antitoxin is most valuable as a prophylactic.

Streptococcus antitoxin seems to have been useful in certain pyæmic cases, and Watson Cheyne believes he has had excellent results from its employment prior to operations on the throat and mouth where absolute antiseptic precautions were, of course, not possible. It is obvious that it cannot effect any good where the staphylococcus is the noxious agent, and a reliable staphylococcus antitoxin is still a desideratum.

The preparations used should be clear, sterile, and procured from a reliable source. There are special hypodermic syringes used for administration, which can be sterilised by boiling before and after use.

F. Instruments and Appliances for Various Operations.

Previous to an operation, and preferably the night before, it is well to lay out the necessary instruments and, in addition, others which are likely to be required, should any complications or emergency arise. If the steps of the operation be gone over *seriatim*, and each instrument selected as it would come into use, there is little chance of any omission. In the following lists, the requirements at the more common major operations have been mentioned; but, in order to avoid repetition, the first two lists on Anæsthesia and General Requisites have been given separately, and must be added to each of the others. Immediately after use, the instruments must be carefully cleansed and dried, and again inspected before being put away.

* Address, 1 Southwark Street, London Bridge, S.E.

I. **For Anæsthesia** (see page 16).—Chloroform, ether, hypodermic syringe, strychnine, artery forceps (Fig. 21), towel or inhaler, gag.

II. **General Requisites.**—Forceps—dissecting, dressing, artery, compression (as Kocher's, &c.)—aneurism needle, director, retractors and blunt hooks, scissors, needles, silk, catgut, drainage tubes, sponges, syringe, lotions, dressings, bandages, safety-pins, mackintosh, razor to shave with.

III. *Amputations.*—Tourniquets; amputating knives—these, if to be used for *transfixion*, should be half as long again as the diameter of the limb to be removed; saws, bone- and lion-forceps, splints; also I. and II.

IV. *Excisions.*—Tourniquets, strong bistouries, periosteum detachers, butcher and ordinary saws; bone-, lion-, and necrosis-forceps; gouge, sharp spoon, splints; also I. and II.

V. *Necrosis.*—Tourniquets, probe, bistouries, periosteum detacher, gouge, mallet and chisel, bone- and necrosis-forceps, splints; also I. and II.

VI. *Trephining.*— Bistouries, periosteum detacher, trephines, Hey's and Gigli's saws, elevators, gouge-forceps, fine aspirator needle, sinus forceps, tooth-picks; I. and II.

VII. *Operations on Jaws and Excision of Tongue.*—Tooth forceps, mouth gag, bistouries, metacarpal saw, bone-forceps, lion-forceps, strong scissors, vulsellum [bradawl and wire]; small sponges, firmly secured to holders, or tied on sticks, are required; and if a preliminary tracheotomy be employed, or a tube passed into the larynx, the suitable instruments must also be provided; I. and II.

VIII. *Tracheotomy* (see p. 109).

IX. *Excision of Breast, Ligature of Vessel, Hernia, and Operations on Rectum and Anus.*—Bistouries, and I. and II.; Macewen's hernia needles.

X. *Operations on Urethra.*—Warm boracic lotion, and syphon or syringe; catheters, silver and gum-elastic; grooved staff, grooved probe, Syme's staff, instruments for internal urethrotomy, bistouries, gum-elastic catheter; carbolic oil, 1-20; I. and II.

XI. *Operation for Stone.*—Warm boracic lotion, and syphon or syringe; sound, catheters,

Crushing.—Bougies for dilating urethra, tenotomy knife, lithotrites, set of evacuators and washer out, extra pillow for pelvis.

Cutting.—Lithotomy knives and staff, bistouries, lithotomy-forceps, and scoop, blunt hooks and retractors, lithotomy tube; also I. and II.

XII. *Operations involving the Peritoneal Cavity and Colotomy.*—Intestinal clamps, Paul's tubes, Murphy's buttons, intestine silk, fine needles, needle holder. Where a cyst has to be removed, an aspirator or ovariotomy trocar must be in readiness; also numerous large cyst and pressure-forceps, and pedicle clamps. In every case the instruments and sponges are to be carefully counted before and after operation. The lotions should be heated, and the sponges and towels also wrung out of warm lotion. A long mounted needle is often useful in dealing with renal and biliary calculi; also I. and II.

G. Various Practical Hints and Suggestions.

Extraction of Teeth.—The two chief points requiring attention in the extraction of teeth are (1) to get a firm hold of a strong part of the tooth as far up the fang as possible; (2) to loosen the tooth before trying to draw it out.

(1) Since many teeth which require extraction have their crowns more or less softened with decay, the need of taking a firm deep hold will be all the more apparent. The forceps must first be fitted accurately round the neck of the tooth, but not tight enough to hold it; they must then be pushed firmly, and often heavily, between the tooth and its surrounding gum and alveolus before the grasp is tightened. In the *upper jaw*, while the patient leans well back with the mouth open, the operator can easily press his forceps upwards. In the *lower jaw*, however, a different manœuvre is necessary. After the forceps, held in the operator's right hand, have been fitted on to the neck of the tooth, the operator presses them down with the thumb of his left hand placed upon them within the mouth, while the rest of the fingers of this hand are outside the mouth and grasp the lower jaw from below.

(2) As soon as the operator has, in either of these ways, taken a firm grasp of the tooth, he begins to rock it in its socket, pressing always more forcibly outwards, towards the cheek, than inwards. When, by this lateral movement, the tooth has been "started" from its socket, a drawing movement must be added, and, by a combination of the two, the tooth will be extracted. The outward pressure is more effectual than inward pressure would be, partly because the outer wall of the sockets is much thinner than the inner wall, and hence more easily yields, and partly because the fangs of the teeth are broader externally than internally, and hence would resist pressure inwards more effectually than pressure outwards.

Instruments Required (according to J. Smith).*—"Five pairs of forceps will be found serviceable for most purposes, and fewer will not. These are a straight pair, and a pair with the blades nearly at right angles with the handles, both of which will be required for upper and lower roots, and single-fanged teeth; a pair adapted for the lower molars, and two pairs for the upper molars—one for the right and one for the left sides. Many other forms would be desirable, and may be collected, but these five pairs will be found absolutely necessary. It has been stated that the blades at their extremities should fit that part of the tooth they are intended to grasp. In this way it will be seen that for single-fanged teeth these blades will merely require to be adapted for the oval form presented by a transverse section of such fangs—hollowed out, in fact, so as to apply themselves more closely to their surface. For multiple-fanged teeth, the forceps must also be on the same principle, adapted to the form of the surface to which they are to be applied. One pair will be found to answer for the double-fanged molars of the lower jaw; but for the three-fanged molars of the upper jaw, two pairs will be necessary, as these three fangs are always so placed that two of them are next the cheek and one towards the palate; consequently, the forceps which would fit one side will not at all fit the other. With this number of forceps, properly constructed, almost any case of extraction may be undertaken where forceps can be used at all."

How to give a Hypodermic Injection.—To avoid the risk of mistake, the amount of the drug injected should always be calculated rather than the number of minims of solution. This is necessary, because the same drug is often prescribed for subcutaneous injection in solutions of different strengths.

Having determined the quantity of fluid to be injected, the operator

* Notes on Dental Surgery, by J. Smith, M.D., LL.D., &c., 1887; Maclachlan & Stewart, Edinburgh.

either leaves only that amount in the syringe, or having filled the syringe, adjusts the screw on the piston, when that special form of instrument is used. Next, he raises the needle end of the syringe, taps it to cause air-bells to rise, and gently expels them. Then, with the left forefinger and thumb, he pinches up a fold of skin, and, after dipping the needle into carbolised oil, boldly plunges it through to the *loose subcutaneous tissue*, into which he slowly and steadily drives the fluid. Finally, laying his left forefinger over the point of entrance, he withdraws the needle, and gently rubs the injected fluid into the surrounding tissue.

Before use, an antiseptic lotion should be run through the syringe and needle.

After use, the syringe and needle should be washed out with warm water. Then the wire should be inserted into its interior.

One or other of two forms of syringe are used—one where the number of minims is marked on the glass barrel of the syringe, the other where an adjustable screw is fitted to the piston rod, so that it may be brought to a stop at any desired point. The measurement markings are in this case made on the piston rod, so that by adjusting the screw any given portion of the fluid may be injected from a full syringe.

Lumbar Puncture.—This procedure is employed either for diagnostic purposes or as a means of treatment.

After injuries to the head the presence of blood-stained fluid under abnormally high tension in the lower part of the spinal subarachnoid space may help the surgeon to decide in favour of trephining. In meningitis the fluid drawn off by lumbar puncture should be examined by staining and culture for micro-organisms, and by staining for the nature of the cells present. "In health . . . the cerebro-spinal fluid contains scarcely any cellular elements, no polynuclear leucocytes, and very scanty, small mono-nuclear cells or lymphocytes. . . . In acute microbic affections of the meninges, large polynuclear leucocytes are found, whereas in sub-acute or chronic affections, including tubercle, small mono-nuclear lymphocytes occur" (*Purves Stewart*).

In meningitis from any cause, the relief from headache and torpor, and even from unconsciousness, which is afforded by drawing off fluid by lumbar puncture is often most striking.

In tuberculous and many septic cases the relief is only temporary, but in others it is followed by progressive improvement.

Method of performing Lumbar Puncture.—The patient, bending the spine forwards as much as possible, so as to open up the space between the laminæ of the lumbar vertebræ, may be either in the sitting or the lying posture. The skin over the lower lumbar region is thoroughly cleansed first with soap and water, and then with 1-20 carbolic or other antiseptic solution of similar strength.

For an adult a hollow needle from 3 to 6 inches in length, and rather thicker than a hypodermic needle, is selected, and boiled. A "serum" needle or large hypodermic needle will suffice for a child. Since the fluid flows out as soon as the cavity is reached, the needle need not be attached to its syringe.

The interval selected is usually that between the fourth and fifth lumbar laminæ which corresponds with a line drawn between the highest parts of the iliac crests. The spot selected is either exactly between the

fourth and fifth spines, or about ½ an inch on either side of the spines. Iodine painted on the selected spot is a useful guide. Freezing with ethyl chloride or ether is an advantage. The needle, after piercing the skin, is pushed steadily inwards and slightly upwards. Lessened resistance indicates the arrival of the point within the canal, and after the dura mater has been pierced the fluid drops from the needle.

How to give an Enema.—Enemata or clysters are used for many purposes:—

(1) *For Clearing out the Rectum.*—For this purpose a large amount of fluid, a pint or more, is required, of warm water, either plain or made more stimulating by the addition of soap-suds, common salt (2 tablespoonfuls per pint), castor oil (½ to 1 oz.), turpentine (1 oz.), sulphate of magnesium (1 oz.). Glycerine in small quantity also acts most rapidly and efficiently, and may be employed as an enema (1-2 drachms injected with a small syringe), or as a suppository either of strong glycerine jelly or saturated on a plug of cotton wool about the size of a filbert nut.

Some patients, after a soap and water enema, are troubled with an erythematous rash of the skin, which may cause considerable irritation, and last some days. It may cause alarm, but is not serious.

(2) *For Cleansing the Mucous Membrane*, when it is ulcerated or diseased.—For this purpose, although an enema of Condy's fluid or other weak antiseptic solution may be employed, a better way is to irrigate the rectum. Two tubes or large-sized catheters should be passed into the rectum—one to carry in the fluid, the other to lead it away. A douche can or Higginson's syringe may be used.

(3) *For Nourishing the Patient.*—When the stomach cannot retain food or drink, or where complete rest to the alimentary canal is required, the absorptive power of the rectum must be utilised. As the rectal mucous membrane cannot digest, all nutrient enemata should be predigested. Moreover, to ensure retention, the amount at each injection should not exceed 2 ounces. When this form of alimentation is continued for long, the rectum should be cleaned out every second or third day by a large enema of hot water (see also p. 15).

When, with intense sickness, great thirst is complained of, frequent 6 ozs. enemata of warm water will give much relief.

(4) *For Stopping Diarrhœa.*—An enema of 6 ozs. of starch, in which ½ drm. of tinctura opii is suspended, will sometimes be successful when the mucous membrane of the lower end of the bowel is involved.

In Receiving an Enema, the patient should recline on the left side with a towel or mackintosh below him to catch any drippings. As Symington has pointed out, the lowest portion of the rectum is always firmly closed by the immediate contact of its walls. For from half to three-quarters of an inch, therefore, the injection nozzle, preceded by a well-oiled finger, must be firmly and steadily pushed upwards and slightly forwards, until it gets through this elongated barrier. It is then to be directed somewhat backwards. After it has got through the outer barrier, the nozzle can be retained with ease; but short of this, it will be ejected at once. The same applies to the introduction of suppositories. Some patients prefer to introduce the enema nozzle themselves.

The form of instrument most frequently used is a Higginson's syringe. With this, by working a ball, a continuous stream can be produced in one direction.

A syphon or funnel with tube attached, would, however, serve the purpose equally well, and be much simpler (p. 291).

As soon as the nozzle is in position, the fluid must be slowly and steadily pumped in, or allowed to flow in.

How to make Poultices.—Poultices are now much less used than they were. When required, the material chiefly used in hospitals for making them is linseed meal; but oatmeal, starch, bread, bran, &c., may also be employed. Care must be taken in making poultices that they should turn out neither too dry nor too moist.

(1) *To make a Poultice of Linseed.*—Have a kettle of water boiling, linseed meal, two kitchen bowls (1 large, 1 small), a spatula, old linen, 1 or 2 heated plates.

First put some boiling water into the larger basin, into this basin place the smaller one, which must have previously been heated by allowing boiling water to stand in it for a minute or two. Put the linseed meal required into the smaller basin, pour in boiling water gradually, and beat with the spatula into a thick paste.

Now take one of the heated plates, lay out on it the linen in which the poultice is to be placed, and spread over it quickly with the spatula the mixture from the basin. Dip the spatula into the larger basin of boiling water, otherwise the mixture will stick to it, and not spread freely on the linen. The poultice should be about ½ inch thick all over, and a margin of about 1½ inch should be left all round the linen to turn up over the edge of the poultice.

If the poultice has to be carried some distance to the patient, it should be placed between two heated plates.

The poultice should be gently applied, and, in the event of there being much discharge from the wound, lay some absorbent cotton wool round it; over the poultice a piece of waterproof material; and then cotton wool or flannel to retain the heat better. The poultice should be fixed in its place by a bandage or handkerchief.

Poultices should be applied as hot as the patient can bear them, without any material between the sore and the mixture, otherwise their value is diminished. They should be changed at least every three hours. The poultice should at once be burned after removal.

(2) *Oatmeal Poultices* are made in the same way as linseed, but some authorities recommend that the meal should be previously boiled.

(3) *Bread Poultices.*—Boil some stale bread with water for five minutes. Drain off the water, and spread the bread on a piece of linen. A few drops of warm oil should be placed on the poultice, and so prevent it from sticking to the patient.

(4) *Bran Poultices* are made by pouring boiling water on to the required quantity of bran, and stirring well.

Antiseptic Precautions.—To any of the above poultices there may be added powdered charcoal, powdered boracic acid, or iodoform, to diminish fœtor and fermentation. The material should also be freely dusted over the surface of the sore, before the poultice is applied.

(5) *Mustard Poultice.*—Failing mustard leaves, either spread mustard, prepared as if for use at table, on linen, or simply shake dry mustard over a linseed poultice, and then apply it to the patient.

(6) *Boric Starch Poultice (Cold).*—Add a teaspoonful of powdered boric acid to four tablespoonfuls of cold water starch, mix with a little cold water, then pour in a pint of boiling water, and stir till melted; let stand till cold; spread the cold starch *thickly* on pieces of cotton, cover

with muslin, and apply to the part, changing the poultices every few hours, before they become hard.

How to Cleanse and Purify Sponges.—Sponges, when new, are to be repeatedly washed out of hot water, dried, and beaten until the sand is shaken out. Some recommend that they should then be steeped in an 8 per cent. solution of hydrochloric acid, until all calcareous particles are dissolved. They are then to be stored in 1-20 carbolic acid, and kept ready for use.

After having been used at Operations for some time.—(1) Free them from grease by steeping in a concentrated solution of washing soda.

(2) Then soak in a 1 per cent. solution of permanganate of potash for 15 minutes, and afterwards wash with water till the latter is clean and colourless.

(3) Next soak for 15 minutes, or until sufficiently bleached, in the following solution—*i.e.*, dissolve ½ lb. hyposulphite of soda in 1 gallon of water and add ¼ lb. of oxalic acid to which enough warm water has been added to dissolve it.

(4) Again wash in water until scentless, and store in 5 per cent. carbolic acid. Sponges used in abdominal surgery should be stored apart, and used for nothing else. (In ordinary cases, after operations, the second and third directions may be omitted.)

During an operation sponges should be squeezed dry of blood, and wrung out of 1-40 carbolic or 1-2000 corrosive sublimate lotion.

In all cases where *putrid discharges* have to be soaked up, masses of **absorbent wool** should be used instead of sponges.

How to Fill a Water-bed.—This should be done after it has been laid on the bed. The water must be warm, and should only about half fill the water-bed. To avoid the disagreeable rumbling, so often noticed when the water-bed is moved in any way, we must get rid of the air as follows:—After the water-bed has been filled, lift up the part to which the filler is attached, either by tilting the bedstead or by lifting the water-bed with the hands. Now partially roll up the other end of the water-bed; as this is done the air will be pressed out, and when there seems no more to come, screw on the cap and let the water-bed return to its place. About once a month a little water should be added to the water-bed.

Directions for Using a Catheter when the Patient can pass it himself.—*Required*—A bottle of 1-2000 corrosive sublimate or biniodide of mercury lotion; carbolic oil 1-30, or eucalyptus oil 1-20; a clean glass syringe, holding 3 or 4 ozs.; a scalded bowl or dish; boric lint; long paper envelopes; soap and water, and clean towel.

(1) Arrange the apparatus in a convenient way.

(2) Wash the hands well with soap and water, then with the lotion.

(3) Syringe lotion through the catheter, and let it lie in the lotion.

(4) Wash the orifice of the urethra and glans penis with a piece of the lint dipped in the lotion.

(5) Remove the catheter from the lotion, shake off superfluous fluid, and after smearing it with the lubricant insert it along the urethra into the bladder.

(6) After withdrawing the catheter, wash it well with soap and water, and run first water then lotion through it. Dip it in the lotion, then wrap it in a clean piece of boric lint, and lay it in an envelope till required.

It is a good plan to order about 4 ozs. of the lubricant, along with an

empty ounce bottle of long shape. The smaller bottle only is used for lubricating, and its contents are thrown away and renewed at least once a week.

A red rubber catheter should be employed if possible, as it can be boiled. This should be done at least once a week as an extra precaution. Gum elastic catheters are spoiled by boiling.

Lubricant of Oscar Krauss for Urethral Instruments :—

Gum tragacanth, ...	2 grs. 50.
Glycerine, ...	10 grammes.
Carbolic lotion, 3 per cent., . . .	90 ,,

Beck's Method of Filling Sinuses with Bismuth Paste.—The paste is made by boiling 60 grammes of vaseline and gradually mixing with it 30 grammes of subnitrate of bismuth.

A glass syringe, with a blunt conical nozzle, is sterilised, dried, and charged with the paste while fluid.

The mouth of the fistula is cleansed with alcohol and wiped free of discharge. A strip of gauze is placed in the opening. The nozzle of the syringe is then inserted into the sinus, surrounded with the gauze as packing, if need be, and the paste is steadily forced in until the patient complains of the pressure. After withdrawal of the syringe, gauze is packed into the opening till the paste has solidified. Water must not be mixed with the paste.

As soon as the paste has set, an X-ray photograph is taken, and the shadow of the bismuth paste will reveal the course of the sinus, and often its unsuspected diverticula.

If any necrosed fragments of bone are present they will be masked by the paste, so that to diagnose such fragments an X-ray picture should be taken, and the fragments should be removed if possible, before the injection is made.

These injections are often curative in themselves.

Sweating Leg Bath.—Leg bath or deep pail filled to within 3 inches with water at 37°-38° C. (99°-101° F.). Patient, undressed, sits on chair with warm flannel pad, and enveloped with warmed blanket; raise temperature by scooping out water and adding 1 pint boiling water against the side every two minutes, as high as can be borne, up to 45°-47° C., and continued for twenty minutes; will perspire profusely; dry lightly with warm rough towels, and put to bed between blankets; extra bedclothes and hot drinks will continue sweating.

H. Various Formulæ (for Lotions, Caustics, &c.).

Urethral Injections.—(*a*) *Antiseptic.*—Watery solution of protargol, ½ to 1 per cent. Watery solution of sulpho-ichthyolate of ammonium, 2½ to 5 per cent. Sulpho-carbolate of zinc, 2 grs. to 1 oz.; corrosive sublimate, ⅛ gr. to 1 oz. (nearly 1-4000); chloride of zine, ⅙ to 1 gr. to the 1 oz.; boracic acid, saturated.

(*b*) *Astringent.*—Acetate of lead, 1 to 2 grs. to 1 oz.; sulphate of zinc, 2 grs. to 1 oz.; nitrate of silver, ¼ gr. to 1 oz.; alum, 5 grs. to 1 oz.

Evaporating Lotion.—℞. Ammoniæ chloridi, ℥i; spirit. rect., ℥i; water, ℥x. To this ℥i of dilute acetic acid may be added.

Caustics,—(1) *Vienna Paste.*—Caustic potash, 5 drms.; slaked lime, 6 drms.; rectified spirit sufficient to make a mass. Spread on the part to

be cauterised, and allow it to remain for 10 or 15 minutes. Surrounding skin protected by adhesive plaster (*Squire*). (For epithelial surfaces.)

(2) *Sulphuric Acid.*—Made into a paste with charcoal or sawdust applied to the desired place for 8 to 10 hours in a guttapercha tube softened and fitted close. (For sloughy and hæmorrhagic tumours.)

(3) *Bougard's Paste.*—Mix in a glass or china mortar, wheat flour, 60 grms.; powdered starch, 60 grms.; powdered arsenic, 1 grm.; cinnabar, 5 grms.; sal ammoniac, 5 grms.; corrosive sublimate, 0·50 grm.; add slowly solution of chloride of zinc at 52° (C.), 245 grms., stirring well. In a covered jar this may be kept for months.

(4) *Chloride of Zinc*, deliquesced and made into a paste, with equal parts of flour may be applied directly, or in lint or gauze, and kept on from 3 to 24 hours.

(5) *Lund's Styptic Discs.*—Steep blotting paper in alcoholic solution of tannic acid—45 grs. to absolute alcohol 1 drm.; dry, and cut into small pieces for application to bleeding points.

(6) *Lund's Application for Strumous Glands.*—Potass. iod., ʒiv; amm. bromid., ʒij; glycerini, ʒi; aq. rosæ, ℥i. Mix and add sp. vin. rect. q.s., ad. ℥iv. Paint on "many times during 24 hours."

(7) *Horsley's Wax.*—Ceræ alb., ʒij; ceræ flav., ʒiv; acid. carbolic, ʒss: vaselini, ʒiv. Used as a styptic, to be rubbed into bleeding bony surfaces.

Mouth Wash, recommended by Mr. Guy.—Phenol, ʒi; sodii hydroxide, grs. x; glycerine, ʒiv; aq. rosæ, ad. ℥iv. If colouring is required add tr. lavand. co., *m*xx. Two teaspoonfuls in a wine-glassful of water to be used as a mouth wash.

Sawdust Bags as an Antiseptic Dressing.—Drs. A. and E. Neve, of Cashmir, have used bags of sawdust for many years in their extensive surgical practice. They are pupils of Lister, and thorough antisepticians.

As adapted to this country, the following method has been used with much success in the Royal Infirmary, Edinburgh. The bags are made of opened bleach gauze, such as is used for swabs, and are in three convenient sizes—4 × 6 inches, 6 × 8 inches, and 10 × 12 inches, or thereabouts:—

The sawdust should be of pine wood, the softer the better, so as to get absorption into the wood as well as between the particles. The coarse fragments are first removed by means of a sieve. The bags are partially filled (*i.e.*, so that they may adapt themselves easily), and stitched up by a convalescent patient or a nurse. They are then sterilised by steam, and removed from the "kettle" or packet by the surgeon when the wound is being dressed. The sawdust diffuses the discharge better than absorbent wool, or, in fact, than any other dressing with which we are acquainted. Its cheapness is self-evident. The objections to it are its bulkiness and weight in certain positions. In most instances, however, these qualities are an advantage in causing the dressing to act as a splint. A layer of bicyanide gauze is laid next the wound; then the bags are fitted in position, and secured with a bandage. The preliminary soaking in corrosive sublimate recommended by Dr. Neve is probably unnecessary, because the mercuric salt will be decomposed by the sterilisation in steam. The risks of discharge soaking beyond the aseptic area would certainly be much less with sawdust than with cotton wool.

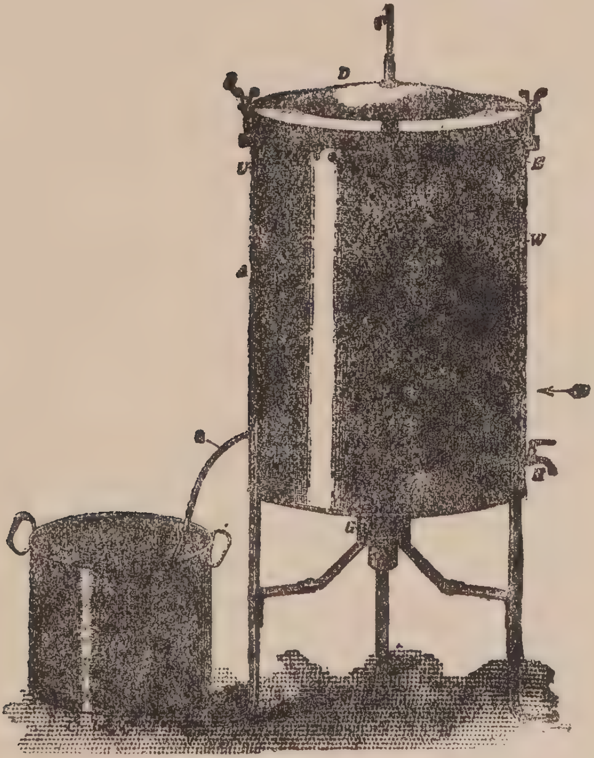


Fig. 200.—Schimmelbusch's Steam Steriliser.

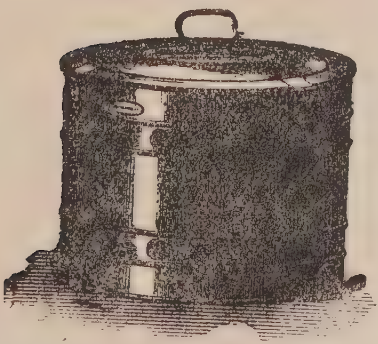


Fig 201.—Metal box or casket used for the Dressing &c. in the Steam Steriliser.

Antiseptics in Time of War.

The *Prophylactic* application of antiseptics as used when operating upon unbroken skin, and also the *Curative* application as employed in determining a primary purification of a recently infected wound, is discussed in Chap. iv.

The curative antiseptic method of Lister has given us better results than any other in compound fracture, and may again be detailed. The customary sterilisation of instruments, towels, swabs, gloves, etc., if not attainable may be replaced by disinfection with carbolic lotion (pure phenol) 1 in 20.

A tourniquet arrests hæmorrhage. The whole area and the skin beyond are now purified with the lotion, and may be covered with the carbolic swab during the administration of the anæsthetic should that be required. The wound is then thoroughly washed out with 1 in 20, the parts manipulated freely so as to cause the lotion to penetrate into the interstices of the wound. The gloved finger may now gently explore its recesses. Clots, foreign bodies, and *completely* detached portions of bone are extracted. Tissues impregnated with sand and dirt and the bruised and soiled skin margins of the wound may be removed with scissors. The tourniquet is relaxed, bleeding checked, and the wound once more washed out, carrying the lotion gently into every nook and cranny by means of a syringe, avoiding forcible injection. Drainage tubes are introduced, and counter openings made so as to eliminate every question of tension. This thorough purification of the wound entails a copious serous outflow due to the action of the antiseptic, hence a large and efficient dressing charged with a suitable antiseptic is essential, and this must be renewed whenever discharge appears.

In the case of compound dislocations Lister frequently used a lotion of one part of phenol in five of spirit. The knife and bone forceps were used to pare and remove portions of cartilage and bone engrained with foreign matter.

Unfortunately, the excellent results thus gained in civil practice have not been realized generally in the present war. This may be ascribed to the enormous rush of casualties overwhelming the dressing stations, which render it well nigh impossible to expend the necessary time and care required for thorough sterilization. The complicated nature of the injuries, the character of the infecting organisms, the question of transport, all present special difficulties. Hence it follows that great numbers of men arrive at the base suffering from already advancing sepsis, foul smelling and suppurating wounds. For such cases a suitable antiseptic agent is a desideratum, and has apparently been found in preparations of chlorine as suggested by Lorrain Smith, Dakin, and Carrel. We can strongly recommend, after successful experience, *Hypochlorous acid*, a non-poisonous, unirritating, efficient and cheap antiseptic, in the forms introduced by Lorrain Smith,* namely, Eusol and Eupad.

"Eupad powder is composed of equal weights of boric acid and bleaching powder. The boric acid is in sufficient excess to set free the hypochlorous acid in the solution. The bleaching powder should be dry, and should contain 28 to 30 per cent. available chlorine.

* Lorrain Smith, *B.M.J.*, July 24, 1915.

"The solution Eusol is prepared as follows:—Add to 1 litre of water 25 grams of the powder; shake well; allow to stand an hour; filter. The clear solution is Eusol, and contains about 0·5 per cent. hypochlorous acid. If the bleaching powder is old or not up to the strength given above, use a larger quantity of the powder. A rough and ready method of preparation is to add $\frac{1}{2}$ oz. of the mixed powder to 1 pint of water, stir or shake, and allow the sediment to settle. In cold weather the solution will keep its strength for three weeks. In hot summer weather it loses its strength more rapidly, and should not be kept more than one week. It keeps best in bottles of coloured glass in a dark cupboard.

"For use as a lotion the solution must be warmed. This may be done by placing the bottle in a basin of hot water, or the solution may be made double strength (50 grms. to the litre), and diluted with an equal volume of hot water. The double strength solution will not keep its value for more than two days."

"Hypochlorous acid is an extremely active bleaching agent, and it should therefore not be brought into contact with coloured fabrics. Further, if cloth is kept in the solution for some time, its fibres are made brittle from destruction of the texture. Any towels, etc., which become wetted by the lotion should be forthwith rinsed in a large quantity of water to remove the acid as rapidly as possible. It is also corrosive to metals; instruments, needles, etc., should be carefully treated, else they will rust."

Eusol is employed in a lotion to irrigate and cleanse wounds, and as a dressing in the form of moist gauze with requisite drainage, all covered by an impermeable layer of gutta percha or the like. The dressing should be changed every four hours according to circumstances, or at least recharged with Eusol by means of a syringe, or again the form of constant irrigation may prove valuable.

In place of Eusol, the powder Eupad, 2 grms. enclosed in a pad of sterile gauze may be placed in the wounds. It requires the addition of a little water if the discharge be too scanty, and should be renewed after 24 hours.

These applications rarely give rise to pain, but should this occur it is met by dilution of the Eusol, or by smearing the surrounding skin area with vaseline should Eupad prove irritating. Delay in healing may call for a change to boracic acid or the like, but even then sepsis is already under control.

The extremely rapid action of Eusol as a deodorant is astonishing. In cases of extravasation of urine, in foul-smelling wounds of the mouth and jaws, in middle ear discharges and septic cystitis speedy improvement has been observed. Fraser has advocated its value in gas gangrene,* and he has also recorded several remarkable instances —an experience shared by others—in which, on the recommendation of Lorrain Smith, the *Intravenous injection* † of Eusol, 40 to 100 c.c. of a 0·5 per cent. hypochlorous acid, to which was added 8·5 grains of sodium chloride per litre, was successful in profound septic toxæmia.

* Fraser, *B.M.J.*, Jan. 29, 1916.
† Fraser, *B.M.J.*, Jan. 15, 1916.

Appendix I.

I. Steam Sterilisers for Dressings and Instruments.—Steam sterilisers, on the principle introduced by Schimmelbusch (Fig. 200), are managed as follows:—Fill the boiler by means of a filler through the tube E, to the level of the arrow mark —×. Place the leaden steam exit pipe in the bucket K, which should be half filled with cold water. Fill the metal boxes (Fig. 201) with the dressings, aprons, and towels required. See that the perforations are open, and place the boxes within the steriliser. Put on the heavy lid and screw it down. Plug the lid with cork and thermometer T, cork the tube E. Light the large gas Bunsen beneath the boiler G. The temperature should be maintained at about 100° C. for one hour. During this time the steam penetrates the dressings thoroughly, and the steam escapes, condensing, into the bucket. Now extinguish the light, and remove the cork. Let the steam escape, and proceed to remove the lid. This should be done by *partially* loosening all the screws S, *seriatim*, and then freeing them completely. The boxes are now lifted out; the perforations closed, and the contents are ready for use.

II. Simple Form of Steriliser.—This, which is much cheaper, is quite as efficient, and in some ways more useful than Schimmelbusch's pattern. It consists of an oval tin vessel (A) like a fish kettle, measuring

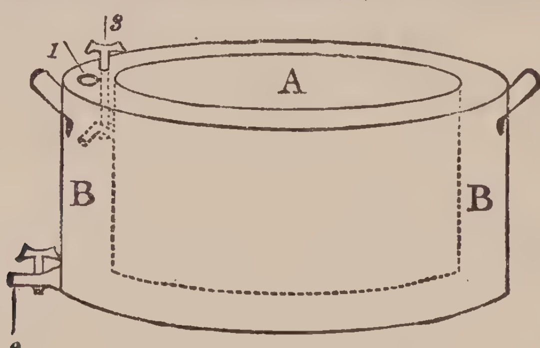


Fig. 202.—Cathcart's Steriliser.

16 inches long, by 9 inches wide at its broadest part, and 10 inches deep. It is surrounded, except where the lid fits on, by a larger vessel (B) of similar shape, an inch of space being left between them. In the outer chamber there are (1) the hole for filling in the water, or letting out the steam when so desired, a cork to plug the hole being chained beside it; (2) an exit tap for emptying out the water; (3) a stop-cock which, when turned on, opens steam communication between the upper part of the outer chamber and the lower part of the inner one half way along one side (the pipe which conducts the steam is shown by a dotted line in the diagram); and (4) a water gauge, not shown in the diagram. The lid fits firmly and closely into the top, but no attempt is made to make the junction steam-tight. In order to reduce as far as possible the condensation which is apt to occur on the under surface of the lid, it is made double with an air space of about ¾ of an inch between the layers, and over the top is spread a loose cover of non-conducting material.

The size of the apparatus permits of its being placed on any kitchen

range, the steam escaping by the chimney; but if desired it can be heated by a gas or paraffin flame. When heating the contents of the inner chamber (before and after sterilisation) the cork is left out of the filling hole (1) and the stop-cock (3) is closed. When steam is to be introduced the stop-cock is opened and the filling hole plugged with the cork. Should by mischance the stop-cock be closed while the hole is also plugged there will be no exit for the steam in the outer chamber, but the cork will be blown out before the pressure gets very high. In order to hasten the drying of the contents of the steriliser after the steam has been shut off, it is advisable to loosen and slightly raise the lid.

The "kettle," or box, in which to sterilise gauze swabs or dressings consists of an oval, or four-sided tin-box (5 by 3½ inches or thereby), each end open but provided with a detachable lid. One of the open ends is partially obstructed by pieces of wire soldered in diagonally or crosswise to facilitate the filling of the box. A piece of gamgee tissue, a little larger than the open end of the box, is first inserted down to the wire, and made to fit that end all round, the gauze swabs are then laid upon it till the box is full, room being left for a second piece of gamgee tissue to cover everything in. The "kettles" are placed open in the steriliser with their lids lying beside them.

When required to prepare dressings in a private hospital, or in the patient's house, the steriliser itself can be used as a "kettle," with the advantage of keeping everything hot if the hot water be allowed to remain in the outer chamber. For ordinary private work, however, another method is preferable. Instead of sterilising articles for each operation it is better to sterilise what we may call dressing or operation "units," and keep them ready, wrapped in packets. These units can be put together in any proportion at a moment's notice, and many years of experience of this method has proved it to be quite safe. Thus sets of artificial sponges of various kinds, for big or small operations, nail-brushes in pairs, balls or lengths of gauze, operation cloths, aprons, and so on, are laid in the steriliser, each in its own parcel, the parcels not being tightly packed together. The gauze swabs in groups of five are kept in the "kettles," just described, the aprons, operation cloths, and other articles, in separate bags, made of "swan's down" cloth or other dust proof material.

After an hour of sterilisation, the contents are dried for thirty or forty minutes.

The stop-cock is turned so that the steam escapes without entering the steriliser, and the lid is loosened so as to permit the steam which still remains to escape.

When the drying is finished the lids are merely slipped over the ends of the kettles without disturbing the protecting layers of gamgee tissue.

And as an extra precaution the kettles should be wrapped in paper (previously cut to the proper size), which is sterilised along with the dressings. The paper wrapping is fixed with sealing wax.

The bags and kettles in paper are laid in a drawer till required.

To meet the requirements of many surgeons, this steriliser is now made in a cylindrical form. The drum for it has holes in the top and bottom, and the steam, which enters the bottom of the inner chamber at the centre, rises up through the drum and escapes at the lid. The makers are A. Young & Sons, Forrest Road, Edinburgh.

Nurse Ibbotson has a simple plan for bandages or towels used in dressing cases in private houses. She wraps the articles to be sterilised in two cloths or towels, and steams them in a potato steamer for

an hour, over the kitchen fire. She then places the whole parcel to dry in the oven with the door not quite closed. When the articles are dry, she removes the outer of the two towels, and keeps the articles wrapped in the inner one till they are needed.

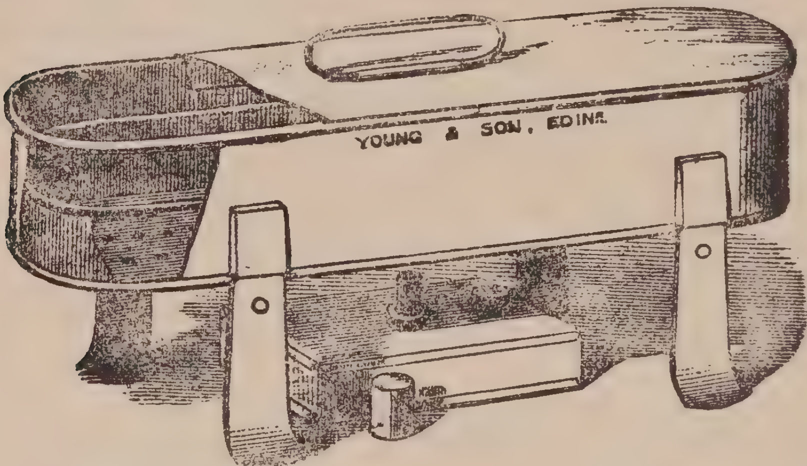


Fig. 203.—Instrument Steriliser, with Lift-out Tray and Spirit Lamp, to carry in Surgeon's bag. Interior size, 13 × 14 in.

Other forms of portable sterilisers for instruments are in the market such as Fig. 203. The lamp, supports, and instruments required may all be packed within the steriliser together with reels of silk. The pan should be filled with hot water to which carbonate of soda has been added (a tablespoonful to the quart), in this the instruments are boiled for ten or fifteen minutes immediately before use, and are then transferred in the lift-out tray to cold carbolic lotion. If they are carefully cleaned and dried after the operation there is little trouble from rust, and if they be nickel-plated there is none at all.

Substitute for Glass Instrument Cases.—With the object of preserving surgical instruments from dust, it is now the fashion to keep them in cases made entirely of glass and iron, and furnished with doors which fit air-tight. A simpler and much cheaper plan consists in keeping groups of instruments in separate glass jars. Confectionery jars are the best for the purpose, because they have no neck or constriction at the top, and being largely used for their own purpose, are sold very cheaply. The lid fits loosely, and by pasting a layer of cotton wool along the part where it comes against the rim, we can ensure that the junction is practically dust-proof (Fig. 204). A ground glass stopper, while not more efficient as a preventive against dust, is much more expensive, and not so readily taken out and put in.

Fig. 204.

A number of jars, of various sizes, having been cleaned and provided with the cotton wool fitting, can be sterilised and dried in the steriliser just described, if so desired, although rinsing with 1-20 carbolic and drying before the fire seems sufficient. In these jars the instruments are placed in sets, those required for similar purposes being kept by themselves as far as the size will allow.

J. Use of the Cystoscope.

It is well to ascertain some time before the examination that the urethra is not contracted. If necessary bougies should be passed.

The patient should drink at least half a pint of water or weak tea half an hour before the examination, to ensure a free flow of urine from the ureters.

The bladder should be washed out if pus or blood be present. In men it is generally advisable to instil a few drops of 5 per cent. solution of novocaine into the prostatic urethra a few minutes before the examination.

Adrenalin chloride may be of use in several ways. Thus, 20 to 30 drops of the 1-1000 solution instilled into the membranous and prostatic urethra will check the bleeding which is sometimes set up by the passage of the instrument; if there is oozing from the bladder wall so as to obscure the field of vision, filling the interior of the bladder with a weak solution of adrenalin for a few minutes generally enables the examination to be made without difficulty. Bleeding into the bladder in spite of the adrenalin probably comes from the kidney.

The cystoscope should be tested before use. By looking through the tube in daylight objects should be quite distinct at distances of from ½ to 2 inches from the prism.

Whatever battery is employed (see p. 215), the current should be gradually turned on (the cystoscope being immersed in fluid) to a little beyond the point when the glow prevents the eye from recognising the threads of the lamp.

Thus, besides the cystoscope and battery, we should have ready—

(1) Soft catheter, warm boric lotion, and funnel or syringe for washing out the bladder (see p. 13).

(2) Acorn-headed catheter (the same catheter as was used for washing out will suffice if the acorn-headed kind is not available) and small syringe for instilling cocaine or adrenalin solution.

(3) Bottles of adrenalin solution and of 5 per cent. cocaine solution.

(4) Glycerine as a lubricant.

K. Use of the Sigmoidoscope.

Directions for the Use of the Sigmoidoscope (after *Mummery*).—The tube part of the instrument can be sterilised like any other metal instrument, but the lamp portion must be dealt with differently. The lamp rests about an inch from the inner end of the tube, and so is not easily soiled, but, if necessary, it can be washed with green soap and water and carefully dried.

Preparation of the Patient.—In ordinary cases the bowels should be opened by an aperient twenty-four hours before the examination, and

three hours before the examination a large enema of plain warm water should be given.

Where the bowel is irritable as from ulcerative colitis, or where there is a tight stricture in the sigmoid colon, Mummery advises that no aperient be given, but that the bowel should be kept quiet by one or two doses of opium and astringent medicines, with an enema of warm water two hours before the examination.

Unless the bowel is very sensitive, or the patient very nervous, it is better not to give a general anæsthetic.

Position of the Patient.—For women or for men when under a general anæsthetic the semi-prone position is recommended, the patient lying on the left side with the buttocks at the edge of the bed or table, and a firm pillow below the left hip.

For men not under a general anæsthetic, the genu-pectoral position is recommended.

The obturator should be in position at first. The tube having been warmed from the outside (to ensure the inside remaining dry) and well smeared with vaseline, it should be steadily pressed in, following the course of the bowel, for about six inches. Then the obturator is withdrawn, the lamp inserted, and the glass-cap fitted on so as to close the proximal end. Some air can be now pumped in. The instrument after this point is guided onwards by sight, the bowel being inflated by the pump as required. The greatest difficulty is found at the sacral prominence posteriorly, where also a valve anteriorly separates the sigmoid flexure from the rectum.

When at this level the bowel seems to end in a cul-de-sac, the opening will be found to be lower down and in front. After the tube has entered the sigmoid flexure it has usually to be turned towards the patient's left, occasionally to the right.

Appendix L.

Preservation of Pathological Specimens with Natural Colour Retained.—The method of *Jores* which is a modification of that introduced by Melnikow Raswedenkow has been tested by T. Shennan, in Edinburgh, and has given most excellent results. Solutions required :—

(1) Sodium Chloride, 1 part.
Magnes. Sulphate, 2 parts.
Sodium Sulphate, 2 ,,
Water, 100 ,,

(2) Formalin as sold (*i.e.*, a saturated solution of Formaldehyde gas (40 per cent.) in water.

A. is a 5 per cent. solution of (2) in (1).

B. Methylated spirit—*i.e.*, about 94 per cent. alcohol and water.

C. Equal parts of glycerine and water.

First wash all free blood and blood clot from the specimen, then, if possible, cut specimen into slices of about 1½ inches thick, and steep in solution A for 48 hours (according to size of specimen 24 to 36 hours), change the solution if it gets turbid. The specimen at this stage will be

blanched. Now lay it in a dish or plate and pour B over it to wash off A, but no water must be used.

Next steep specimen in B till the colour returns, this will take about 24 hours; to prolong the stay in spirit only bleaches the specimen again. Transfer into C, in which the specimen will float until the spirit is replaced by the glycerine.

After two or three weeks mount in a fresh supply of C and seal down. Before the permanent mounting it is sometimes an advantage to take a thin slice off the surface of the section—a brighter colour and better differentiation of parts are thus obtained.

Appendix M.

Preparation of Catgut.—Catgut is made from the intestine of the sheep by scraping away the mucous membrane, and the peritoneal and muscular coats, thus leaving only the delicate *sub-mucous connective tissue.* This is twisted and dried, as a whole, or in strips according to the thickness required.

Lister's Sulpho-Chromic Catgut.—"The preparing liquid must be twenty times the weight of the catgut. So for 40 grains of catgut 800 grains of preparing liquid are required. It is made by mixing two liquids —namely, the chromium sulphate liquid and the sublimate liquid.

"The sublimate liquid is:

Corrosive sublimate, ...	2 grains.
Distilled water, ...	320 ,,

"The sublimate may be dissolved by heat, but the solution must be used cold.

"The chromium sulphate liquid is prepared thus:

Chromic acid, ...	4 grains.
Distilled water, ...	240 ,,

"Add to this as much sulphurous acid (*P.B.* solution) as gives a green colour. If more is added the colour becomes blue, which shows that rather too much sulphurous acid has been used. It is well to reserve a few drops of the chromic acid solution, to be added after the blue colour has just appeared and restore it to green. Then enough distilled water is added to bring the green liquid up to 480 grains. Then add the sublimate liquid."

The catgut is kept twenty-four hours in the preparing liquid, and is then dried on the stretch.

N.B.—It is essential that the CrO_3 and SO_2 solutions be mixed before the $HgCl_2$ solution is added.

Catgut prepared in this way remains actively antiseptic in its substance for an indefinite period.

"But while the substance of the catgut is thus not only aseptic but powerfully antiseptic, its dry surface is liable to contamination by contact with septic material, and it is essential that, before being used, it be washed with some trustworthy germicidal liquid.

"My practice has been to put the catgut, like the instruments, in a 1-20 solution of carbolic acid about a quarter of an hour before the operation is begun. Any of the catgut that remains unused upon the reel may be afterwards kept in a similar solution for any length of time without disadvantage."

Sterilising Dehydrated Catgut in Absolute Alcohol in a Closed Brass Vessel (*Jellett's*).—(1) Roll the raw catgut *very loosely* on glass plates.

(2) Place in absolute alcohol for three or four days to ensure dehydration.

(3) Transfer to one of the metal sterilising cylinders (Fannin & Co., Grafton Street, Dublin; Reynolds, Branson & Co., Leeds; &c.) made for the purpose; fill it three-quarters full of absolute alcohol, and screw the lid on tight.

(4) Place the cylinder in a sauce-pan of cold water, but interpose some wool or lint between the bottom of the sauce-pan and the cylinder to prevent over-heating.

(5) Bring the water to the boil, and continue the boiling for fifteen minutes.

(6) After it has cooled, transfer with sterilised forceps to the storage jars. The gut contracts about 1 per cent. of its length during the heating, hence the reason for its being wound loosely. The contraction does not, however, affect the formation of a ball if the catgut has been previously rolled in this form instead of on a plate or spool.

Ether and Corrosive Sublimate Method.—(1) Soak the raw catgut for a week in commercial sulphuric ether.

(2) Then for a week in 1-4000 solution of perchloride of mercury in ether.

(3) Transfer to storage solution.

Iodine Method.—By the use of iodine, catgut can be easily prepared, and becomes not only aseptic, but antiseptic as well.

At first a watery solution of iodine was used; 1 part of iodine, 1 part of iodide of potassium to 100 parts of water. After eight days in this solution the catgut is ready for use, but it soon becomes brittle if stored in this solution, so it has then to be dried and kept in this condition till used. A better method of using iodine is Salkindsohn's *Iodine Spirit Method Solution*:—Tincture of iodine (B.P.) 1 part, proof spirit 15 parts (*i.e.* very nearly the 50 per cent. alcohol which Salkindsohn recommends).

The catgut is immersed in this solution for eight days, after which it is ready for use. In addition, it can be stored in the same solution for an indefinite length of time without deteriorating.

Care should be taken that the bulk of fluid is largely in excess of that of the catgut, and that if the solution becomes pale it should be poured off and fresh solution substituted.

To Chromicise Catgut without making it too hard.—(1) Prepare the following solution:—Dissolve 15 grains of bichromate of potash in 1 oz. of boiled and distilled water; add this to 15 ozs. of absolute alcohol.

(2) Steep the catgut in this solution for 15 hours.

(3) Transfer to

Storage Solutions for Catgut.

(*a.*) Iodine spirit solution.

(*b.*) Absolute alcohol, ... 90 pts.
Glycerine, ... 10 ,,
Corrosive sublimate, ... 0·5 ,,

(*c.*) Olive oil containing 20 per cent. of carbolic acid—*i.e.*, 1-5 carbolic oil.

(*N.B.*—Since it was shown that carbolic oil was slow and unreliable for *sterilising* catgut, surgeons have been afraid to use it as a storing fluid,

There is, however, no real ground for this fear, and the advantages of strong carbolic oil as a storing fluid are many and great.)

Storage Solution for Silk.—1-1000 of corrosive sublimate in absolute alcohol.

Methods of Drawing off Catgut during an Operation.—The requisites are ease of obtaining the catgut thread, preservation from contamination of the catgut not used, choice of different thicknesses, and facility in replacing new supplies when a given quantity has run out. Many more or less complicated vessels fitted with sets of spools or reels have been introduced, but none have proved quite satisfactory in all of the required particulars, and we have to fall back on a choice of two simple methods. One is to have yard or metre lengths of catgut rolled on separate spools, which are removed from the bottles during an operation and laid on the instrument tray, but not used again for any other operation. This necessitates a considerable waste of catgut. The other method is to roll the catgut in balls like those of twine. These pull out from the middle and are used as follows:—Keep two or three balls of catgut—different sizes—in a small wide-mouthed bottle, or use several small bottles each containing balls of catgut of the same size. Before the operation begins remove the cork or stopper, placing it on an aseptic surface, and draw out a few inches of each thread of catgut; now pack round them into the mouth of the bottle a plug of cotton-wool, firmly wrung out of some antiseptic lotion. The threads will thus pass through the plug. When catgut is required, the surgeon steadies the plug with his left hand, while he draws at what he wants of any of the threads with his right and cuts it off (Fig. 205). After the operation the plug is thrown away and the stopper replaced. As soon as a ball is finished, another can be put in the bottle from a stock which, of course, will be kept ready. Thus, the requirements laid down are fulfilled with no apparatus except a bottle, and the operator can help himself to catgut during an operation without contaminating his hands.

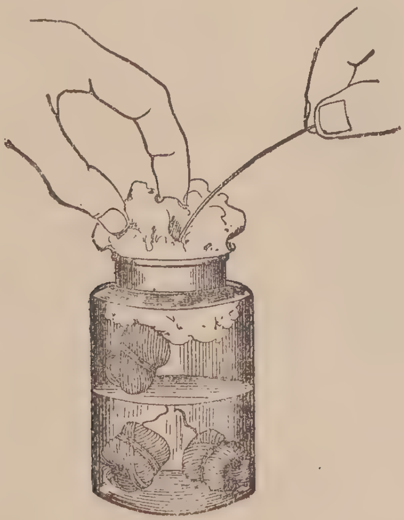


Fig. 205.

How to Roll Catgut in Balls.—Take a surgically clean glass rod and tube varying from $\frac{4}{16}$ to $\frac{6}{16}$ inch in diameter for different thicknesses

of catgut. If the catgut is dry, damp it in antiseptic lotion to take off some of its springiness. Keep it lying loose on a plate or in a bowl. Holding the rod in the left hand, fix the end of the thread with the

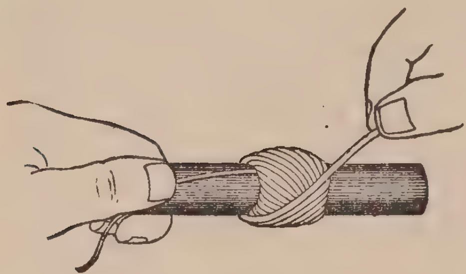


Fig. 206.

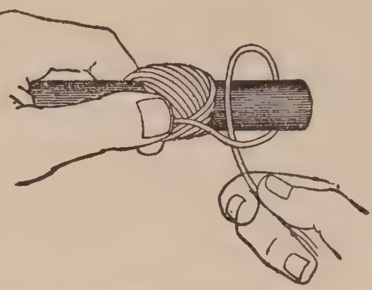


Fig. 207.

fingers of this hand against the glass (this will be the end which draws out). Grasping the thread with the right hand, wind it once or twice round the rod near its free end. Now begins the special method. The thread is wound obliquely round and round the glass rod, each complete turn touches the rod twice, and every turn overlaps the previous one (Fig. 206). When a good-sized ball has been formed it is fixed thus:—As the thread passes from below it is steadied with the left thumb halfway up the ball (Fig. 207); it is then fixed there by being looped on itself and drawn tight, and lastly is secured by laying down the end and being whipped in position by two or three turns. The loop is then drawn through and the end cut short. Meanwhile, the first end has remained under the operator's left hand. The ball is now finished, and it has only to be carefully pulled off the rod to be ready. Twisted ligature silk can be easily rolled in the same way, especially when wet. Although the very finest silk can also be put up in this way, the balls are soft and collapsible and spools are better. Like most things this process seems more difficult from the description than it is in reality. Let any one try it with a piece of firm twine on a ½-inch diameter rod, and with a little practice it will become quite easy. The winding must not be too tight, else the ball when finished will not slip off the rod.

Fig. 208.

A convenient modification of the plan of rolling in balls is to roll the catgut in "spirals" of about 12 to 18 inches long. The catgut in these short lengths is wound round the glass-rod. It is then pulled off and the free end is fixed by a simple turn or twist. The "spirals" can be lifted out of the bottle one by one. The inner end draws out easily.

Gauze Dressings in Balls.—The same method may with advantage be used for gauze dressings. Fold a length of gause across its breadth

till it is an eighth of its original breadth. Wind it on a glass-rod about ¾ of an inch in diameter. As the muslin passes through the hand it forms itself into a loose cord. Finish the ball by tucking the end under the last turn. The ball may then be sterilised.

Prepared gauze, such as bicyanide or iodoform gauze, is usually sent out by the manufacturer in rolls folded to one-eighth of the breadth of the "piece." It is thus ready to be made into a ball. When finished, the ball should be fitted into a surgically clean jar or box, and the inner end brought up through a plug of cotton wool (Fig. 208). When required for dressings, portions can be drawn up and cut off as required without disturbing the remainder. Iodoform gauze should have a stoppered jar.

Messrs. J. F. M'Farlan & Co. will send out any of their prepared gauze dressings in ball form, if requested to do so, and can supply suitable celluloid boxes to hold them.

Appendix N.

Pirquet's Cutaneous Tuberculin Test.—This is based upon the hyper-susceptibility of tuberculous patients to tuberculin, and is believed to be due to the coming together of the toxin (tuberculin) and the anti-body which is developed by a patient suffering from a tuberculous lesion.

Method—Materials Required.—A lancet, or a platinum vaccination needle, which can be sterilised in the flame. Koch's old tuberculin undiluted, and a 25 per cent. dilution of the same in ½ per cent. solution of carbolic acid. The diluted solution of tuberculin is used for children, and by some practitioners in all cases; but in adults a negative result with the weaker solution should be followed by a test with the full strength tuberculin.

The *best site* for innoculation is the inner side of the forearm, where the skin is delicate and free from hairs.

"The skin is rubbed with ether, two drops of tuberculin placed on it at a distance of about four inches apart, and circular scarifications made with the needle, first midway between the two drops, and then in the middle of each" (*Bandelier* and *Roepke*).

The tuberculin is allowed to soak in for some minutes. No dressing is required. The positive reaction in most cases is well seen in twenty-four hours, but attains its maximum in forty-eight hours. It consists of an area of swelling and redness from 10 mm. to 20 mm. in breadth.

The negative reactions resemble the condition of the control scarification made between them.

For a careful review of the other methods of employing tuberculin in diagnosis and for guidance in using tuberculin as a therapeutic agent without the technical difficulties of the opsonic index, the reader is referred to *Tuberculin in Diagnosis and Treament*, by Dr. Bandelier and Dr. Roepke (John Bale, Sons & Danielsson: London, 2nd English Edition, 1913).

Appendix O.

Shorthand in Medicine.—"The service of shorthand in medical work is most extensive in the ability it confers to secure notes of cases, which could not otherwise be taken. The practitioner, by its means, can keep useful records even through a busy life, and the notes which the physician has to take, can be made twice as good in half the time and with less than half the labour. In all scientific medical work, and indeed in all scientific work which rests upon observation, it enables, in a given time, the amount of record to be doubled, and yet leaves twice the time for observation, which must be more precise and accurate for the greater record. It has thus a special influence on the quality of the work. To the student also it is of extreme value in taking reports of cases. It enables him, moreover, to take perfect epitomes of lectures, and yet to give to the subject as much attention as if he took no notes. It enables him also to secure notes of the bedside teaching, the most precious he receives, which can seldom be obtained with longhand, and yet leaves him adequate time for all necessary observation of the facts.

"Nothing that is worth having can be acquired without some time and labour. Shorthand may be so learned that it can be used with advantage if one hour a day is given to its study for three months. In the case of many students with well-trained minds, three-quarters of an hour a day will suffice, or half an hour a day for four months, if the practice in writing is supplemented by reading in various spare moments. At the end of three months it can be used: it can be written at about twice the rate of legible longhand, and read with ease. A few minutes of study each day, to secure accuracy, enables its use to be adequate for further progress during the second three months. During the second six months, all the time that has been given to its study is regained by its use. At the end of the year there has been no actual loss of time, and afterwards all is pure gain. Shorthand is a lever which, unlike mechanical levers, increases alike the value of time and the power of work."*

Arrangement of Notes of Cases.—It is essential that the notes of cases should be so arranged as to be easily referred to. Many methods may be employed, but the following seems the best in our judgment:—

For private work the cases should be taken in separate sheets of thin tough paper, 6½ by 4½ inches. These can be carried in a parchment envelope in the breast pocket. As soon as the case is finished, or during its progress, if the case is seen only in the consulting room, it is put away in a partitioned and alphabetically labelled portfolio (8vo size, to be had for 1s. or 1s. 6d. at any large stationer's). At periodical intervals the cases are taken out of the portfolio, arranged according to the disease and indexed in a book according to the name of the patient. The system of diseases adopted must be drawn up beforehand, and will probably vary with the line of practice of each individual;† but for most people, and especially for students, the headings of the Chapters of Standard Text-books will give a basis to start with. The method

* From a leaflet issued by the *Society of Medical Phonographers* (Pitman's System).

† Messrs. A. & D. Padon, 13 St. Andrew Square, Edinburgh, publish Cathcart's *Index for Surgical Cases.*

recommended for indexing according to name is that described in Todd's *Student's Manual.* A good thick notebook is taken, and the pages are marked as follows:—Each letter of the alphabet has 10 pages allotted to it—*i.e.*, two for each of the vowels, a, e, i, (y), o and u. The patient's name is then entered primarily according to the first letter in the name and secondarily according to the first vowel. Thus, J. Smith or Simpson would be entered on page S, i; Sloan, on page S, o; Anderson, on page A, e, and so on. Following the name there would be a reference to the disease and the number of the case. Thus, against J. Smith's name might stand "Knee, Tuberculosis, 15"—*i.e.*, the 15th of the tubercular knee cases. There still remains to be described the method of storing the cases, which are grouped together according to the disease. Nothing seems more suitable for a practitioner than an adaptation of the "Ceres" system. A number of separate cardboard slips is placed in a box. They lie slanting against one another, steadied by a support which can be moved along at will as more space is required. Instead of the letters which are sent out fixed upon the slips the practitioner pastes the names of the diseases fixed on in his plan. Between the slips go the cases—arranged either in direct series or preferably with several pinned or gummed on to a broad sheet (a student would find one or two of the portfolios before-mentioned would sufficiently suit his purpose, if the partitions had names of diseases pasted over the letters).

The advantages of the method now recommended are that (1) full use is made of the admirable business expedient of simultaneously storing and indexing. While a patient is still in attendance his name gives the index to his case-sheet. Afterwards when the medical man wishes to refer to similar cases of a given disease he finds them grouped together. Should, however, he wish to find the case through the patient's name, he has the book index for reference. (2) Notes of the same patient's case are kept together. (3) He has no bulky note-book to carry about with him.

In hospital practice the only difference is that the cases are usually taken on larger sheets of paper than those recommended for private work.

P. SICK-ROOM COOKERY RECEIPTS.

By Miss A. M. Griggs.

Since the proper cooking and serving-up of food are so important in the nutrition of patients, we make no apology for adding a series of well-tried sick-room cookery receipts to our Surgical Handbook. For these we are entirely indebted to Miss A. M. Griggs, who tested their value and used them in her classes.

Soups and Beef Tea.

Chicken Soup. Required—A young chicken (the remains of the chicken, of which the breast was used in the chicken panada, p. 345, may be utilized).

2 pints fresh cold water.
½ teaspoonful salt.
12 peppercorns.
1 blade of mace.
Small "bouquet garni" (*i.e.*, a sprig of thyme, parsley, and bayleaf).
Yolks of 2 eggs.
1 gill of cream.
Slice of dry toast.

Cut the chicken into small joints, remove the skin, and put the joints into a basin with sufficient boiling water to cover them, and allow to stand for 10 minutes to remove all fat. Pour away the water, and wash the chicken joints in cold water, then put them into a china-lined saucepan, with 2 pints of cold water, the salt, peppercorns, mace, and the bouquet garni. Let the mixture boil, skim thoroughly, and then simmer for about 3 hours till the meat is parting from the bones; strain and set aside to get cold. Take the meat from the bones, pound it in a mortar and pass through a hair-sieve, then mix with the yolks and the cream. Carefully remove every particle of fat from the liquid strained from the bones, and pour the liquid gradually over the pounded chicken mixture. Stir over the fire until quite hot, but do not allow to boil or it will curdle and the soup be spoiled. Serve with toast cut into neat pieces.

Mutton Broth (inexpensive). Required—

1 lb. lean mutton.
1½ pints cold water.
¼ teaspoonful salt.
1 tablespoonful of rice or 1 tablespoonful of pearl barley.
Thin dry toast.

This broth should, if possible, be made the day before it is required. Cut the mutton into small pieces, take away all fat and skin, put the mutton into a china-lined saucepan, with 1 pint of water and the salt. Cover with a lid and bring slowly to the boil, and then skim carefully. Simmer for two hours, and skim occasionally. Add the rice (which must previously be well washed in cold water) and ½ pint cold water, and allow the broth to simmer for one hour more. Strain and put aside for twelve hours to become cold. Remove the fat. Heat as required, keeping back the sediment. Serve very hot with a slice of thin dry toast.

[The flavour may be varied by the addition of a small carrot, a piece of onion, or a few herbs. The rice or barley may be omitted, and the broth will be perfectly clear.]

Fish Soup (inexpensive). Required—

1 haddock (medium sized).	1 gill milk.
1 pint cold water.	1 teaspoonful of corn flour.
1 small potato.	½ ,, ,, salt.
1 oz. butter.	¼ ,, ,, pepper.
2 leeks.	

Wash the fish thoroughly and remove the scales; cut it into pieces, and put it into a very clean china-lined saucepan, with the cold water and salt. Allow to come to the boil, with the lid off, and skim thoroughly. The perfection of the soup depends greatly upon this first skimming. Add the potato and white part of the leeks thinly sliced. Boil up once, skim well, and cover with a lid, and let the soup simmer slowly for 1 hour. Pass the fish, &c., through a sieve, keeping back the bones. Return the soup to the pan. Mix the corn flour with the milk, and keep free from lumps; pour into the pan, stir until boiling, and serve the soup very hot.

At the end, ½ teaspoonful of lemon juice and 1 tablespoonful of finely-chopped parsley may be added to vary the flavour.

Beef-Tea. Required—

1 lb. freshly-killed lean beef. 1 pint cold water.
½ teaspoonful salt.

Remove all skin and fat. Cut the beef into small pieces; do not chop it or a good deal of the juice will be squeezed out and lost. [A still better plan is to scrape or shred the beef, as this breaks it more thoroughly down and allows the water to mix better with it. This plan takes a long time.]

Place the beef, with the water and salt, in a stone jar, with a tightly-fitting lid, and allow to stand for 10 minutes. This soaking in cold water and salt will draw out the juices of the meat. Then place the covered jar in a saucepan (with a lid) half full of boiling water, and cook thus for 60 minutes. If the water in the saucepan boils away, add more. The reason beef-tea is put into a jar, and not directly into a saucepan, is to prevent it from boiling, which is considered to diminish its digestibility.

[If more convenient, the jar containing the beef, &c., may be placed in a moderately hot oven and cooked there.]

When the beef-tea has been cooking for 30 minutes, open the jar, and with two forks separate the beef, which is apt to cake together into lumps; cover and return the jar to the saucepan. When the beef-tea is sufficiently cooked, pour it off from the meat, but do not strain it, at least not through a fine strainer, as that would keep back the sediment, which is a valuable part of the beef-tea. Pour into a basin, and squeeze the meat with the back of a spoon so as to get out all the juice.

If there is a suspicion of any fat floating on the top, remove it with porous paper; or better still, let the beef-tea, if not required at once, become cold and remove the fat with a heated spoon.

If the patient is allowed to eat the fibre of the meat, pound it in a mortar, pass it through a hair sieve and thicken the beef-tea with it.

As patients quickly tire of beef-tea, it is advisable to alter the flavour occasionally. By the addition of a sprig of parsley, thyme, and bayleaf tied together and put into the jar for about 15 minutes, and removed before serving, a pleasant flavour will be obtained. If the flavour is liked, a small piece of onion, previously scalded, may be placed in the jar for a few minutes while the beef-tea is cooking. Any vegetable or herb palatable to the invalid may be used for a change. A tea made of equal quantities of lean beef, veal, and mutton, in the proportion of 1 lb. of mixed meat to 1 pint of water and ½ teaspoonful salt, is often palatable.

Serve beef-tea hot, in a cup or bowl only ¾ parts full in case of spilling, with thin dry toast cut into small neat pieces upon a plate. Place the cup and plate upon a tray, with a clean and neatly-folded napkin.

Beef-Tea quickly made (inexpensive). Required—

4 ozs. of freshly-killed lean beef. 1 gill cold water.
¼ teaspoonful salt.

Cut the beef into small pieces, sprinkle the salt, and pour the water, over it. Cover and allow to stand for 10 minutes. Pour into an uncovered saucepan, place over a slow fire, and beat with a fork until the meat changes colour. On no account allow the tea to boil. Pour the tea off the meat, remove the fat, and serve.

Beef-Tea with Oatmeal (inexpensive). Required—

1 tablespoonful of fine oatmeal. ½ pint of cold water.
1 pint of beef-tea.

Put the oatmeal into a basin and cover it with the cold water, let it stand for 30 minutes, stirring continually, and then strain it through a fine strainer, pressing the oatmeal as dry as possible. Pour the clear part of the beef-tea on the strained oatmeal and water, boil for 10 minutes, stirring continually. Pour on to the sediment of the beef-tea, mix thoroughly, and season.

Raw Beef-Tea. Required—

2 ozs. freshly-killed lean beef.
2 tablespoonsful of cold water.
¼ teaspoonful salt.

Scrape the beef, over it sprinkle the salt and pour the water. Cover and allow to stand for 10 minutes. Stir and pour off the tea, and it is ready.

[A few drops of browning or ketchup will improve the colour of the beef-tea, but be careful to serve it in a coloured or opaque glass as its appearance is not appetising.]

Beef Essence. Required—

1 lb. freshly-killed lean beef. ½ teaspoonful salt.

Cut the meat into very small pieces, sprinkle the salt well over it, put it into a jar and cover with a lid. Place the jar in a covered saucepan of boiling water, or moderately hot oven, for 5 or 6 hours. Press the beef, and pour off all liquid. Remove the fat with a piece of porous paper, and serve a teaspoonful of the essence at a time.

[To hurry the process a tablespoonful of water may be poured over the beef and salt, and two hours will then suffice to draw out a good deal of the juice from the meat.]

Fish.

N.B.—White fish, such as haddock, whiting, cod, or turbot, should always be preferred for invalids to oily fish, such as salmon, herring, or mackerel.

Boiled Fish and Sauce (inexpensive).—Have a very clean fish-kettle, with a strainer, with salted water (1 teaspoonful salt to 1 pint of water), just enough to cover the fish. Too much water will wash away the flavour. Remove the fish from the water directly it is cooked, or it will become soft and broken. It may be kept hot over the water, on the strainer, covered with a cloth or flannel. A whole fish should be put into cold water; a slice or piece of fish into boiling water. Do not pour the water over the fish, but place the fish in the water, directly after it has been well washed in cold water and salt. The time for cooking will depend upon the thickness.

Whiting or flounder requires about		5	minutes.
Sole,	,, ,,	7	,,
Haddock,	,, ,,	10 to 15	,,
Slice of cod or skate,	,, ,,	12 to 15	,,

Put a skewer or fork close to the bone, and, if the flesh feels tender and will leave the bone, the fish is cooked enough. If the flesh feels hard, the fish must be cooked longer, for underdone fish is not only unsightly but most unwholesome.

Sauce for boiled Fish. Required—

A piece of butter size of half an egg.
1 dessertspoonful of flour.
1 small cupful of milk.
½ teaspoonful of lemon juice.
1 tablespoonful of the water in which the fish was boiled.
¼ teaspoonful salt.

Melt the butter, add the flour, and mix over the fire until there are no lumps, pour on the milk and fish liquor, and stir constantly until boiling. Cook for 3 minutes, add the seasoning, and serve with the fish in a separate vessel.

Broiled Fish.—This method of cooking fish is most suitable to small flat fish, or a slice from a thick fish. Have ready a very clear fire, throw on a little salt to allay the smoke. Put on the gridiron, and, when it is

quite hot, rub all the bars on either side with suet, so as to prevent the fish from sticking. Wash well, and dry the fish; rub it with oil, pepper, and salt. Place the fish on the gridiron, and turn it constantly for from 5 to 9 minutes, according to its thickness. Serve hot.

[A more delicate way is to wrap the fish in an oiled paper before putting it on the gridiron. This way requires great care to prevent the paper from becoming charred, and to cook the fish thoroughly.]

Fried Fish. Required—

Flour.	Bread crumbs.
1 egg.	Fish (sole or haddock).

Place on the fire an iron saucepan three-quarters filled with clarified fat or dripping, to become hot while the fish is being prepared.

Remove the skin and bone from the fish, and cut it into pieces about 2 inches square. Wash and dry the fish, then dip it into flour to absorb all moisture, next cover the fish with the egg (yolk and white well beaten together), then toss the fish in bread crumbs. It is advisable to have the bread crumbs in a paper, as then the fish may be tossed without being handled. Try if the fat is hot enough by throwing in a tiny piece of bread. If the bread becomes brown *at once* the fat is ready. The fish may be fried for about 3 minutes, but too many pieces must not be put in at once or the fat will be cooled. On no account put the fish in before the fat is ready, or it will become a greasy sodden mess, instead of a crisp brown appetising morsel. Lift the fish from the fat on to a piece of porous paper to absorb all grease, and serve hot on a folded napkin or fish-paper.

Meats.

Lamb Chop (for a Convalescent). Required—

1 lamb chop from the loin.	Very small piece of butter.
White pepper and salt.	2 tablespoonsful of cream.
(1/8 of a teaspoonful of each).	

Trim the chop neatly, and lay it upon a well-buttered, enamelled dish that will stand the fire. Sprinkle over the chop the pepper and salt, lay on the top a very small piece of butter, and place the dish in a moderately hot oven and cook for about 7 minutes, then baste and turn the chop. Cook for 5 minutes more. Lift the chop on to a hot dish, add the cream to the dripping in the enamelled dish. Place the enamelled dish over the fire, and stir the sauce briskly until it boils and thickens. Pour the sauce over the chop, and serve very hot.

Chop—Grilled, Toasted, or Fried. Required—

1 nice chop, cut and neatly trimmed.

To Grill.—Make ready a good clear fire, have a gridiron perfectly clean and very hot, rub both sides of it in every part with mutton fat, and put it over the fire. Lay the chop upon it, and cook for from 7 to 10 minutes, turning constantly, counting slowly 1, 2, 3, 4 between each turn. This will allow the chop to be nicely browned on the outside, and juicy inside. Serve at once on a very hot dish.

To Toast.—When the fire is not bright on the top, the chop may be toasted in front of the fire, turning frequently.

To Fry.—Make a little butter very hot in the pan, put in the chop and cook, turning frequently. [This method entails less trouble than grilling, but is not nearly so satisfactory.] Time, 7 to 10 minutes.

Steamed Mutton Chop. Required—

1 nice loin chop. Small piece of butter.
White pepper and salt (1/8 of a teaspoonful of each).

Have ready over the fire a saucepan of boiling water, with a deep plate fitting tightly over the top and touching the water. Select a nice chop, remove all skin and superfluous fat, and trim the chop neatly. Butter the plate, and when it is quite hot place the chop upon it. Cover tightly with a saucepan lid, or another plate, being careful that it fits closely. Let the water boil rapidly under the plate for from 7 to 10 minutes, according to the thickness of the chop, then lift the lid or plate, turn the chop, cover again, and allow to cook 7 to 10 minutes more, filling the saucepan with more boiling water if necessary. When the chop is cooked lift it on to a clean hot dish, add the white pepper and salt to the liquid in the plate, mix thoroughly, and pour over the chop. Serve with snow-flake potatoes.

[Any small piece of meat, chicken, or fish may be steamed and served in this manner.]

Chicken Panada. Required—

Breast of a young chicken. About 2 tablespoonsful of cream.
Yolk of 1 egg. Small slice of toast.
1/4 teaspoonful of salt.

Remove the skin from the breast of a young chicken, and cut the flesh into small pieces. Put them into a jar, and sprinkle a little salt over them, cover the jar with greased paper, place it in a saucepan with enough boiling water to come half way up the jar. Cover with a lid and cook for 60 minutes, as the water in the saucepan evaporates, add more, which must be boiling. Remove the chicken from the jar, pound it in a mortar with the yolk, and pass through a hair sieve. Add cream to the juice left in the jar until there are 3 tablespoonsful of the mixture. Pour this on to the pounded chicken, and stir over the fire till it thickens. It must not boil. Dip the toast into hot milk, and pile the chicken mixture on to the toast. If liked, squeeze a little lemon juice over it. Serve hot.

Vegetables.

Snow-Flake Potatoes (inexpensive). Required—

Freshly boiled potatoes from the pot.

Pass the potatoes quickly through a wire sieve, and lift them with a slice on to the hot dish, on which they are to be served, without pressing them in any way.

[If preferred, the potatoes may be heated or slightly browned on the top, after they have been passed through the sieve.]

To boil a Cauliflower. Required—

1 cauliflower.	1 tablespoonful of vinegar.
Water.	Salt.

Remove all the coarse outer leaves from the cauliflower, but let the small close leaves remain to protect the flower. Wash, and place the cauliflower in a basin, with cold water to cover it. Add the vinegar, and let the cauliflower lie for 30 minutes. The vinegar will draw out any insects that may be secreted in the leaves or flower. Wash the cauliflower again in fresh cold water, and plunge into a saucepan of boiling water, containing 1 teaspoonful of salt to 1 quart of water. Let the water boil rapidly till the cauliflower sinks to the bottom of the pan, and the stalk is tender, about 20 to 30 minutes are required. Lift into a hot vegetable dish, and pour sauce over.

Sauce. Required—

1 oz. butter.	½ pint milk.
½ oz. flour.	¼ teaspoonful salt.

Make in the same manner as directed for sauce for boiled fish (p. 343).

Puddings and Jellies.

Custard Pudding. Required—

3 eggs.	½ pint of milk.
1 teaspoonful of sugar.	¼ oz. butter.

Take the yolks of three eggs and 1 white, beat well with the sugar, add the milk. Butter a pie-dish, strain the milk, &c. into the dish, and place it in a *moderately hot* oven to cook for about 10 minutes. The dish must not be moved in the oven until after the eggs are set, or the custard will curdle, and not become firm.

Bread Crumb Pudding (inexpensive). Required—

1 heaped tablespoonful of bread crumbs.	½ oz. of butter.
1 gill of milk.	3 lumps of sugar.
1 egg.	A grate of nutmeg.

Heat the milk, and pour it over the bread crumbs, butter, and sugar, in a basin, beat with a fork until quite smooth. Whip the yolk and white of the egg together, and mix all well together. Butter a small basin, pour in the mixture, cover with a piece of greased paper, and steam for 20 minutes. [For steaming, see beef-tea custard p. 347).

Turn the pudding from the basin on to a hot plate, and serve plain, or with a little jam.

Rice Pudding (inexpensive). Required—

1 tablespoonful of rice.	1 egg.
½ pint of milk.	Water.
1 dessert-spoonful of sugar.	

Wash the rice in several waters, put it into a saucepan with just enough water to cover it, and, when the water boils, stir with a fork and add the milk. Continue to stir occasionally until the rice is tender. Butter a pie-dish, pour the rice into it. Beat the egg with the sugar, and add to the rice. Mix well, and bake in a moderate oven for about 7 to 10 minutes.

Arrowroot Pudding. Required—

½ pint milk.	2 teaspoonsful of arrowroot.
Sugar to taste.	1 egg.

Mix the arrowroot to a smooth paste with about 2 tablespoonsful of cold milk. Warm a cupful of milk, and pour on to the arrowroot, stirring all the time, return to the saucepan, and stir until the arrowroot has boiled 2 or 3 minutes. Sweeten to taste. Allow the arrowroot to become cold, mix in the yolk of egg. Beat the white to a stiff froth, and stir lightly into the arrowroot. Butter a pie-dish, pour in the mixture, and bake for about 5 minutes in a moderately hot oven.

Semolina Pudding (inexpensive). Required—

1 tablespoonful of semolina.	1 oz. butter.
3 gills of milk.	1 egg.

1 dessert-spoonful of sugar.

Put the semolina, milk, butter, and sugar, into a saucepan, and stir over the fire until boiling, and continue to stir for about 5 minutes longer while the semolina boils.

Take the saucepan from the fire to cool a little, drop the yolk of egg into the mixture. Drop the white upon a plate, and beat to a stiff froth. Mix well with the semolina, place in a greased pie-dish, and bake for about 5 or 7 minutes.

Tapioca Pudding (inexpensive). Required—

1 tablespoonful of tapioca.	3 gills of milk.
2 eggs.	1 dessert-spoonful of sugar.

½ oz. butter.

Well wash the tapioca, and cover it with the milk, and allow to stand for 2 hours, stirring occasionally. Then place in a saucepan by the side of the fire, and cook very gently for about 60 minutes, stirring occasionally. [Tapioca must be cooked slowly, or it will become tough and hard. Each particle should be soft and perfectly clear after it is cooked.] Draw the saucepan away from the fire to cool a little, add the sugar and butter. Mix the yolks well with the tapioca. Whip the whites to a stiff froth, stir lightly into the tapioca. Pour into a buttered pie-dish, and bake for about 7 minutes.

Beef-Tea Custard. Required—

Yolks of 2 eggs.	1 gill beef-tea (free from fat).
White of 1 egg.	⅛ teaspoonful salt, to season.

⅛ teaspoonful pepper, to season.

Whisk the yolks and white till quite frothy, add the beef tea. Add the seasoning, and cook by *steaming*. Pour into a buttered basin. Butter a piece of paper, tie this tightly on to the basin, and place it in a saucepan of boiling water, taking care that the water only comes three-quarter parts up the basin. If the water boils away, more must be added. Cover the saucepan with a tightly-fitting lid, and let the custard steam thus for 20 minutes. Do not let the water boil too rapidly, or the custard will become honey-combed instead of being firm and smooth. When cooked, remove the paper, reverse the basin over a hot plate, take away the basin, leave the custard standing, and serve.

[For convenience in tying on the paper, it is advisable to use a pudding basin with a rim at the top.]

Beef-Tea Pudding, steamed (inexpensive). Required—

2 tablespoonsful of fine bread crumbs.
1 gill of hot beef tea.
1 egg.

Pour the beef-tea over the bread crumbs, mix thoroughly, add the egg well beaten and the seasoning. Pour into a buttered basin, and steam for 20 minutes. See directions in beef-tea custard.

Beef-Tea Pudding, baked (inexpensive). Required—

3 tablespoonsful fine bread crumbs.
A piece of butter about the size of an egg.
1 gill hot beef tea.
2 yolks and 2 whites of eggs.

Pour the hot beef-tea over the bread crumbs and the butter, beat with a fork till the butter is melted, then add the 2 yolks; whip the 2 whites to a stiff froth, stir them lightly into the mixture; pour the mixture into a buttered pie-dish, and bake in the oven for 10 minutes.

Port Wine Jelly. Required—

2 wine glasses of port wine.
1 oz. of isinglass.
1 teacupful of warm water.
3 ozs. of white sugar candy.
½ oz. of pounded gum arabic.

Put all these ingredients into a jar. Place the jar in a saucepan, with cold water reaching half-way up the jar. Cover and let the water simmer for about 6 or 8 hours, adding more as it evaporates. Stir the contents of the jar from time to time; when they are all mixed and quite dissolved, pour the jelly into saucers and allow to become cold.

Portable Jelly. Required—

2 ozs. gum arabic.
2 ozs. of white sugar candy.
2 ozs. isinglass.
1 nutmeg, grated.
1 pint of port wine.

Put all into a jar standing in a saucepan of cold water, and stir the contents of the jar until all are mixed and dissolved. Pour upon a plate and, when cold, cut into lozenges and preserve in a tin box.

[Milk may be used instead of port wine, but the lozenges will not keep so well.]

Orange Jelly. Required—

6 oranges.
1 oz. gelatine or isinglass.
4 ozs. of sugar.
1 lemon.
3 gills of water.

Squeeze the juice from the oranges and lemon and add, with the water, to the gelatine and sugar in a clean china-lined saucepan. Stir over the fire until the gelatine is dissolved. Strain through a hair sieve or piece of muslin, and pour into a mould previously dipped in cold water. Let stand 12 hours to become quite cold. Turn on to a clean dish, and serve with, or without, whipped cream.

Bread Jelly (inexpensive). Required—

2 penny rolls. 1 pint hot water.
2 ozs. sugar. 1 stick cinnamon.

Cut the rolls into thin slices, and toast or dry them very thoroughly. Put them into a basin, with the sugar and cinnamon stick broken. Pour the hot water over them, cover tightly, and let the basin stand by the side of the fire for 30 minutes. Pass through a hair sieve or coarse muslin into a mould or small basin. Set aside to become cold, and serve with cream.

Chicken Jelly. Required—

Legs and wings of a young chicken. ¼ teaspoonful of salt.
About 1 pint cold water. 6 pepper corns.
A blade of mace.

Remove the skin from the legs and wings of the chicken. Pour boiling water over them, and allow to stand for 10 minutes. Drain and put the meat and bones into a pan with the water; add the mace, salt, and pepper corns. Put the lid on the pan. [If liked, a small piece of flavouring vegetable (uncooked), such as carrot or turnip, may be added.] Bring to the boil, skim well, and let simmer slowly till the meat falls into shreds. Strain through a piece of muslin, and set aside to become cold.

Omelets, &c.

A Plain Omelet. Required—

A piece of butter the size of a small egg. 3 eggs.
Pepper and salt to taste.

Beat the eggs briskly, add pepper and salt to taste. Melt the butter in a small omelet pan over the fire, skim the butter, and pour the beaten eggs into the pan. Hold the handle, and keep the pan revolving over the fire until the omelet mixture looks nearly the consistency of cream; let the pan then rest over the fire for 1 minute, swiftly slide a broad pliable knife under one half of the omelet, and fold it over the other half to form an oval shape, trim the edges neatly, and tilt the pan so that the lower side of the omelet may become of a golden brown colour, and it will then be ready. Reverse the pan over a hot omelet dish, and serve the omelet quickly with the brown side uppermost. The omelet should be brown and firm on the outside, but soft and creamy inside when broken.

[*Note.*—Be most careful to keep the omelet pan clean, and to use it for nothing but omelets.]

To Poach an Egg (inexpensive). Required—

1 egg. 1 slice of toast.

Have a shallow pan with boiling water; to 1 pint of water allow 1 teaspoonful of salt and 1 tablespoonful of vinegar. Break the egg into a cup, and, when the water is boiling very fast, pour the egg into the pan and let it cook gently for 2 minutes; lift it out, with a perforated slice, on to a piece of nice hot buttered toast, and serve at once.

Drinks.

Coffee (inexpensive). Required—

1 tablespoonful of coffee. ½ cupful hot milk.
1 cupful of boiling water.

The good quality of the coffee will very much depend upon the way in which it is made, and upon the fresh and thorough roasting of the berry. Good coffee should always leave a coloured stickiness round the cup, and should never be boiled, but made with boiling water, and served very hot.

A simple and plain method to make coffee is in a jug. Heat the jug and dry it, put in the coffee and pour the boiling water over it. Cover tightly and allow to stand on the hob, or by the side of the fire, for 5 minutes. Pour a little coffee into a cup and back into the jug. Repeat this, cover again, and leave for 10 minutes to become clear. Serve with hot milk.

[*Note.*—In cooking milk, watch it constantly, and remove from fire just before it boils.]

Tea (inexpensive).—Have a kettle of fresh water, and infuse the tea directly it boils. The long boiling of the water causes the tea to have a flat insipid taste. Make the teapot very hot, and dry it thoroughly. Allow 1 teaspoonful of tea for each person, and 1 teaspoonful over (this is allowing 2 cups of tea for each). Pour on the boiling water, let the tea stand covered from 3 to 5 minutes, never longer. Pour off the tea into a fresh hot teapot or jug. On no account allow the tea to remain longer on the leaves, or it will become bitter.

A Cup of Chocolate. Required—

2 ozs. of chocolate. ½ pint milk.
1 egg. Sugar to taste.

Put the chocolate into a saucepan with the milk, and, when hot, work with a spoon into a smooth paste free from lumps. Stir over the fire and boil for 5 minutes. Beat the yolk and white of the egg to a stiff froth, and strain into a jug, strain on to this the chocolate, and beat with a whisk for 5 minutes, or until the chocolate is quite frothy.

[A small teacupful is sufficient to give at a time with a little sponge-cake or finger biscuit.]

Cocoa (inexpensive). Required—

2 ozs. of cocoa nibs or flakes. 3 pints cold water.

Put the cocoa into a very clean saucepan with the water, and simmer, with the lid on, by the side of the fire for 5 or 6 hours. Strain. Add ½ cup of milk to ½ cup of cocoa.

[Cocoa nibs are cheaper and purer than many of the prepared powders.]

Barley Water (inexpensive). Requred—

2 ozs. of pearl barley. ½ lemon.
1 oz. of loaf sugar. 1 quart of water.

Wash the barley, put it into a clean saucepan, with 1 pint of cold water, allow to boil for 5 minutes, throw away the water and wash the barley again. Return the barley to the saucepan with a quart of cold water, the sugar, and thin yellow rind of the lemon. Simmer for about

2 hours, strain through a piece of fine muslin, squeeze the lemon and add the juice, and allow to cool before serving. Be most careful not to give the sediment; a good plan is to strain off the barley water when it is cold into a second jug.

Rice Water (inexpensive). Required—

1 oz. whole rice.	4 large raisins.
2 pints water.	[1 tablespoonful of brandy, if ordered.]

Wash the rice well, cut the raisins into pieces, but do not remove the stones. Put the rice and raisins into a clean saucepan with the water and boil for about 1 hour. Skim occasionally. Strain through muslin, and serve cold, with or without the brandy, as ordered.

Apple Water (inexpensive). Required—

4 firm apples.	1 pint water.
2 ozs. lump sugar.	3 cloves.

Wash and wipe the apples, cut into slices, but do not pare or core them. Put them into a clean saucepan with the water, sugar, and cloves, and let them come to the boil. Strain through muslin, and serve when cold.

Toast Water (inexpensive). Required—

1 slice of bread. 1 quart of cold water.

Take a slice of bread, about 1½ inches thick, dry it slowly, either in a slow oven or about 1 foot away from the fire. Then slightly brown the bread close to the fire, but do not burn it, put it into the water in a jug. Cover and let stand for 1 hour, strain through muslin, and serve. Make fresh every day.

Wine Whey. Required—

½ pint sweet milk. 1 wineglassful of sherry.

Heat the milk, pour in the wine, and stir until it curdles. Strain, and it is ready to serve. If liked a little sugar may be added after it is strained.

Tamarind Whey. Required—

1 pint milk. 3 ozs. tamarinds.

Heat the milk, stir in the tamarinds, and continue to stir until the milk has boiled 3 or 4 minutes. Strain through muslin, and it is ready to serve.

Treacle Posset (inexpensive). Required—

1 pint milk. 2 large tablespoonsful of black treacle.

Warm the milk, add the treacle, and boil for 5 minutes. Strain through muslin, and serve hot.

Linseed Tea (inexpensive). Required—

1 oz. whole linseed.	1 lemon.
2 tablespoonsful of honey.	1 quart of water.

Wash the linseed, and put it into a saucepan with the water, simmer slowly for 1 hour, skim occasionally. Put the honey into a jug, and squeeze the juice of the lemon over it. Strain the linseed and water on to this. Stir well, and serve a tablespoonful at a time warm.

Camomile Tea. Required—

1 oz. camomile flowers.	1 quart boiling water.

Put the flowers into a jug, and pour the boiling water over them. Cover, and allow to stand for 10 minutes. Strain, and serve cold. Dose, ½ a teacupful.

Lemonade (inexpensive). Required—

3 lemons.	½ pint of boiling water.
2 ozs. of loaf sugar.	

Put the thin yellow rind of fresh lemons into a jug with the sugar. Squeeze in the juice of the lemons, being careful to keep back the pips, pour on the boiling water, cover, and set aside to become quite cold. Strain, and bottle, but do not keep longer than 3 days.

Serve 2 tablespoonsful of lemonade in a tumbler, with potash, soda, or fresh cold water.

A Warm Egg Drink (inexpensive). Required—

1 egg.	½ pint of hot milk.
1 teaspoonful of sugar.	Nutmeg (a grate of).

Beat the egg and sugar until frothy, strain, and pour the hot milk upon them, stirring briskly.

Beat with a fork for 4 minutes, season with nutmeg, pour into a clean tumbler, and serve at once.

A Warm Egg Drink with Wine. Required—

1 egg.	1 gill of hot water.
1 teaspoonful of sugar.	1 wineglass of good port.
Nutmeg (a grate of).	

Beat the egg and sugar together, strain, and add the hot water, stirring all the time, then mix in the nutmeg and wine, pour into a clean warm tumbler, and serve with fingers of toast.

A Refreshing Egg Drink (inexpensive). Required—

1 yolk of egg.	1 teaspoonful of sugar.
1 tablespoonful of milk.	Soda or potash water.

Beat the yolk of egg and sugar together, add the hot milk (or 1 tablespoonful of sherry not heated). Strain into a tumbler, and fill the glass with soda or potash water, and serve while effervescing.

Egg Drink for a Dyspeptic (inexpensive). Required—

1 white of egg.	1 gill of milk.

Whip the white of egg to a very stiff froth, and stir lightly into the milk. Serve with thin dry biscuit.

Egg Cream. Required—

1 gill milk.	Yolks of 2 eggs.
2 lumps sugar.	White of 1 egg.
1 gill cream.	1 gill bramble or black currant syrup.

(*i.e.* ½ gill hot water poured over 1 gill of jam and strained.)

Whip the cream until stiff. Warm the milk and sugar, pour on to the yolks and white, stirring all the time; return to the saucepan and continue to stir until thick, but do not boil or the eggs will curdle. Strain on to the syrup, and when cool add the cream.

[Always strain any mixture containing eggs before giving it to an invalid.]

Oatmeal Gruel (inexpensive). Required—

3 tablespoonsful of medium oatmeal.	Sugar to taste.
1 pint milk.	Small piece of butter.

Put the oatmeal into a basin with the milk, and let it stand for 30 minutes, stirring occasionally. Strain the milk into a saucepan, press the oatmeal as dry as possible, and stir over the fire until boiling, and boil for 10 minutes, still stirring. Pour into a basin over the butter and sugar, and stir until the butter is melted. Serve hot.

[To make gruel from prepared groats—Mix 1 tablespoonful of groats with 2 tablespoonsful of cold milk, add these to nearly 1 pint of hot milk. Boil 10 minutes, and serve hot.]

Rice Gruel (inexpensive). Required—

¼ lb. of whole rice.	1 pint of water.
2 lumps of sugar.	1 inch of cinnamon stick.

[1 tablespoonful of brandy.]

Wash the rice thoroughly, put it into a saucepan with the water, sugar, and cinnamon; let boil, and skim well. Put the lid on the pan and simmer for 60 minutes, when the rice ought to be soft and pulpy. Take out the cinnamon, beat the gruel with a fork to make it of uniform thickness. Serve a little warm, with or without the brandy.

A Cup of Arrowroot. Required—

½ pint milk.	Sugar to taste.

2 teaspoonsful of arrowroot.

Mix the arrowroot to a smooth paste, with about 2 tablespoonsful of cold milk. Warm a cupful of milk and pour on to the arrowroot, stirring all the time; return to the saucepan and stir until the arrowroot has boiled 2 or 3 minutes. Sweeten to taste and serve.

[When wine or brandy is to be served in arrowroot, water must be substituted for the milk, otherwise the mixture will curdle; and the wine added after the arrowroot is removed from the fire.]

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